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ABSTRACT

This collection of interdisciplinary hands-on activities covers a variety of topics related to trees and conservation. Twenty-four activities integrate the subjects of social studies, fine arts, science, language arts, math, geography, and music. Although activity instructions are not consistent they usually contain details on objectives and procedure. Some activities are accompanied by student worksheets. Three lesson plans focus on the biology of trees and contain sections on objectives, materials, activities and alternate activities, and discussion questions. Other activities involve students in examining environmental issues, and experimenting with seeds and plant growth. The collection contains nine poems and a song. A bibliography with 11 entries provides sources from which activities were compiled. (LZ)

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Dear Teachers,

The Sacramento Tree Foundation's "Green Schools Activity Booklet" is an interdisciplinary assortment of tree and environmental activities designed for the enjoyment of students in kindergarten through the seventh grade.

The booklet is a response to your requests for hands-on learning tools. We are grateful to our contributing sources and have included their names and addresses in the bibliography if you wish to obtain original publications.

The Sacramento Tree Foundation is a non-profit organization dedicated to citizen tree planting, stewardship, and education about the "urban forest" of the greater Sacramento area. Our goal is for every student at every school to have the opportunity to plant trees and insure that they are well established in their first three growing years. Toward that end, the Green Schools Activity Booklet is but the first step.

Sincerely,

Adrienne Scott
Education Director

Karen Wong
Assistant Education Coordinator

AMS:dab

Cover design: We gratefully acknowledge artist Greg Bruna for his generous contribution.

5/14/92

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Table of Contents

1. History of Arbor Day, *Social Studies*.....1
2. Mobile From Tree Parts, *Fine Arts & Science*.....3
3. Natural Resource Fill in the Blank, *Science & Language Arts*,.....5
4. Don't be a Litterbug, *Language Arts & Fine Arts*.....7
5. Lion in the Trees, *Math & Fine Arts*.....9
6. Adopt a Tree, *Language Arts & Fine Arts*.....11
7. Tree Collage, *Language Arts & Fine Arts*.....15
8. Alphabet Hunt, *Language Arts & Science*.....17
9. Picture Your Thoughts, *Language Arts*.....19
10. What's Your Angle...Gravity, *Science*.....19
11. What is a Tree, *Science*.....21
12. How a Tree Grows, *Science*.....27
13. Tree Seasons and Cycles, *Science*.....31
14. Identification Game: Getting to know Sacramento's Trees & Plants, *Science, Sportsmanship*.....39
15. A Seed is a Beginning, *Science*.....45
16. Measure for Measure, *Math & Science*.....53
17. Fun with Seeds, *Science*.....55
18. Water, *Science & Social Studies*.....61
19. Cities Change the Environment, *Science & Social Studies*.....63
20. School Energy Map, *Math, Geogragraphy, Science & Language Arts*.....69

21. Classroom Conservation, *Social Studies & Fine Arts*.....73

22. Who Runs This Place, *Social Studies*.....75

23. Arbor Day Poems, *Language Arts*.....77

24. Growing Growing, *Music*.....80

Bibliography 83

History of Arbor Day

"Other Holidays Repose on the Past, Arbor Day Proposes For the Future"- J. Sterling Morton

Tree planting festivals are probably as old as civilization. Throughout the world, school children, men, and women are planting trees, caring for them, and learning their value. In the United States, this 'festival' is celebrated on Arbor Day. In other lands, it may be called Arbor Week, Tree Holiday, or Tree Festival. In Japan, it is called Greening Week. In Israel, where it is changing the entire face of the land, it is called the New Year's Day of the Trees. Korea has Tree-Loving Week. Iceland has a Student's Afforestation Day. Yugoslavia holds an Arbor Day in the Spring and an Afforestation Day in the Fall. India celebrates a National Festival of Tree Planting. The First Arbor Day in the United States was celebrated in Nebraska on April 10, 1872. By that time settlers had chopped down most of the trees in that state either for building their homes or for firewood. Still other trees had to be destroyed to clear the land for farming. You could wander for miles over the western plains with not a tree in sight. A Nebraska newspaperman, J. Sterling Morton, came up with the idea of Arbor Day as a method of correcting this sorry situation. The suggestion gained favor as he launched his "Campaign for tree planting" and inspired the "grand army of husbandmen" to do "Battle against the timberless prairies."

Morton loved trees for their own sake, for their beauty and for the creation of an enjoyable environment. Born in upper New York State in 1832, educated in Michigan, young J. Sterling Morton followed the western movement of the pioneers and in 1854 and settled on the west bank of the Missouri River near the present day town of Nebraska City. By 1872, Morton was a member of the State Board of Agriculture. He later became the United States Secretary of Agriculture.

Arbor Day began inauspiciously. It was simply one of a number of efforts to encourage the planting of trees in barren Nebraska. The State Board of Agriculture offered a prize of $50.00 for the best and largest grove of timber planted in 1870, and $25.00 for the second best and largest. They also offered $15.00 as a prize for the best orchard and row of hedges planted during the year. More than one million trees were planted that first Arbor Day. With observance of this first Arbor Day celebration, J. Sterling Morton became known in history as the father of Arbor Day.

Nebraska had become so active in tree planting that by April 4, 1895, that the legislature passed a resolution that the state be popularly known as the Tree Planters' state. Under the Kincaid Act, the Forest Service distributed 2,000,000 young trees from the Federal nursery to 10,000 residents in addition to the planting done on government land in Nebraska.

Shortly after this observance, other states also passed legislation to observe Arbor Day each year with appropriate ceremonies. By 1920, more than 45 states and territorial possessions were celebrating Arbor Day. During the early years following the first Arbor Day, many thousands of trees were planted by students, civic and church groups, as well as various youth groups, all as a direct result of the creation of Arbor Day by J. Sterling Morton.

In California, Arbor Day is observed on March 7. This date commemorates the birthday of Luther Burbank. Burbank, born March 7, 1849, was known best for his breeding work for improved varieties of flowers, fruits, grains, grasses, vegetables and trees. March 7 is also the opening day of Conservation Week, which has been observed since 1935. Tree appreciation and conservation, tree knowledge, and scientific tree care, are closely associated with Arbor Day.

Many parents and grandparents think fondly of the day when they helped plant a tree. Some of the oldsters revisit the site to admire a magnificent specimen they planted as a small sapling many years ago. Children today will some day come back to visit their school and say, "I helped plant that tree."

MOBILE FROM TREE PARTS

MARERIALS: Objects from nature, scissors, construction paper, cardboard, glue, crayons, and nylon thread or fishing line.

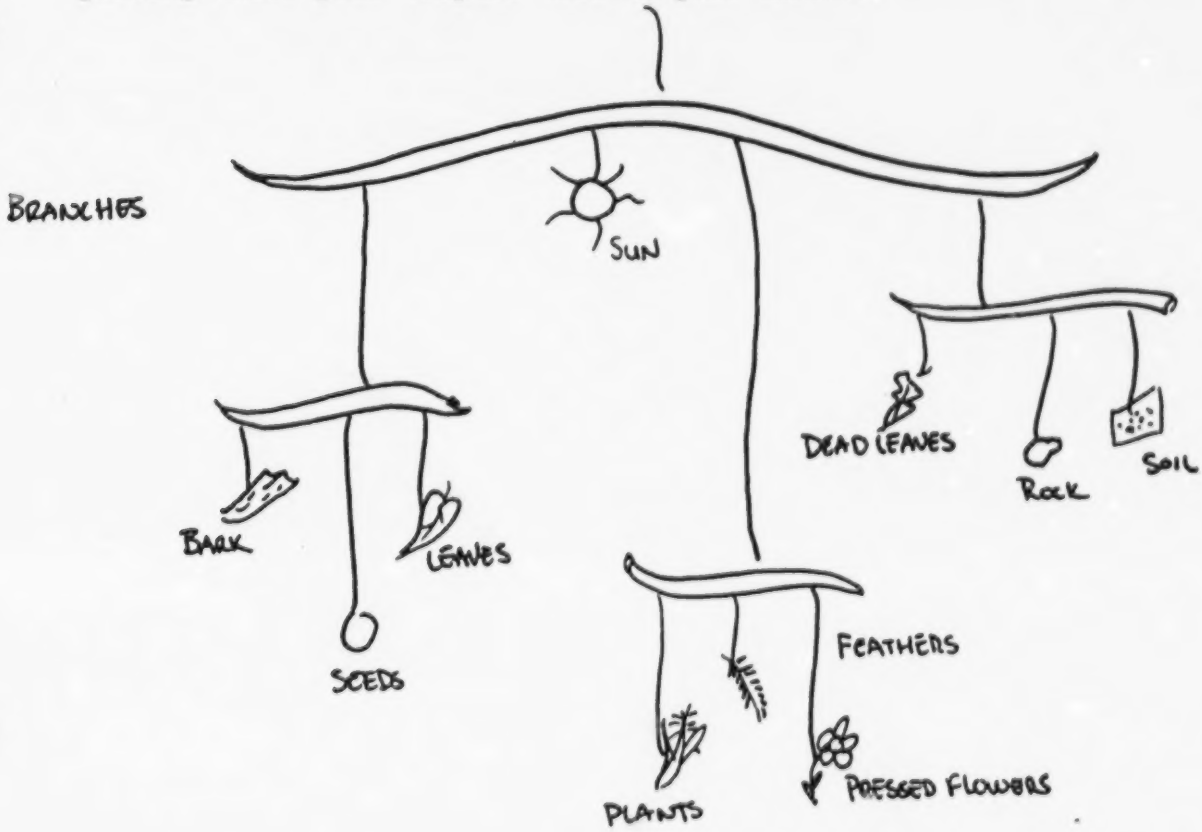
Adopt a tree and gather materials from under and around it for this project. Either hang items directly on mobile or glue them to construction paper or cardboard. Objects may be drawn if necessary.

Begin by using **tree branches** as balance arms. Add **bark** which protects the tree and **leaves** which produce food for the tree. Use **seeds** because each new tree begins as a seed. Draw the **sun** for it powers the leaf factory.

A tree needs **soil** in order to grow. **Dead leaves** will decay into the soil providing the tree with essential nutrients. Glue dead and partially eaten leaves onto construction paper. Minerals are needed for healthy tree growth. Add a **rock** to the mobile.

A tree is home for animals and insects. Add **feathers** or pictures of **animals** and **insects** which might call a tree home.

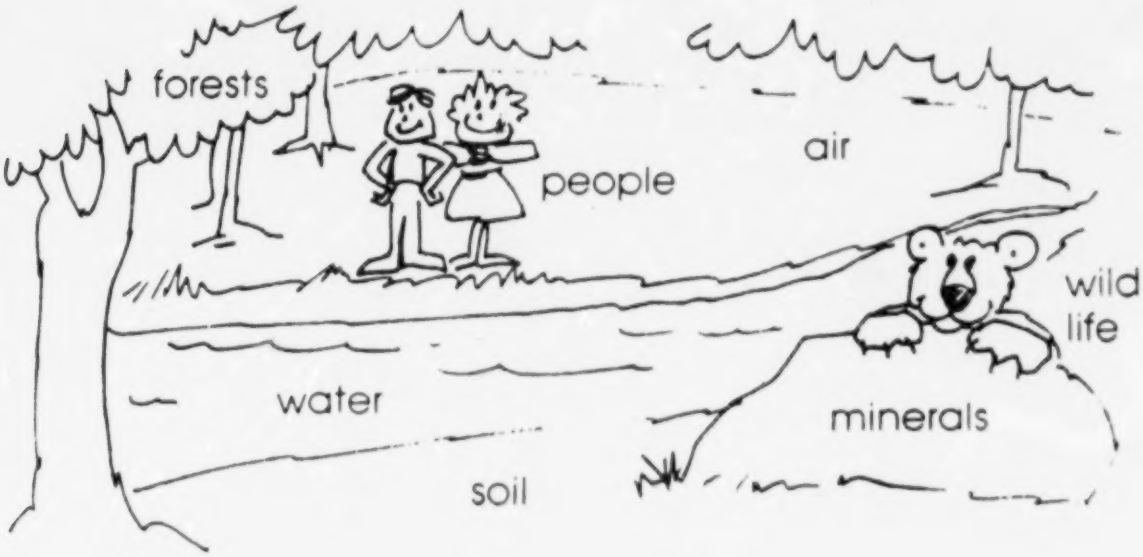
The shade of a tree may provide shelter for other plants. Include a **flower, blade of grass** or any **other plant** you find growing under your adopted tree on your mobile.



Name

_____

Here are seven of our natural resources. Write the name of the correct natural resource in the blank space in each sentence.



1. We need _____ to drink, to bathe in, and to wash clothes in.
2. Plants, animals, and people need _____ to breathe.
3. We need _____ to grow plants in.
4. Salt, chalk, and silver are some of the _____ we use.
5. _____ need to use other natural resources wisely and to save them for the future.
6. We use our _____ for wood to build houses and furniture.
7. Rabbits, bears, and deer are part of our _____ .

Name

Circle the compound words in this story.

DON'T BE A LITTERBUG

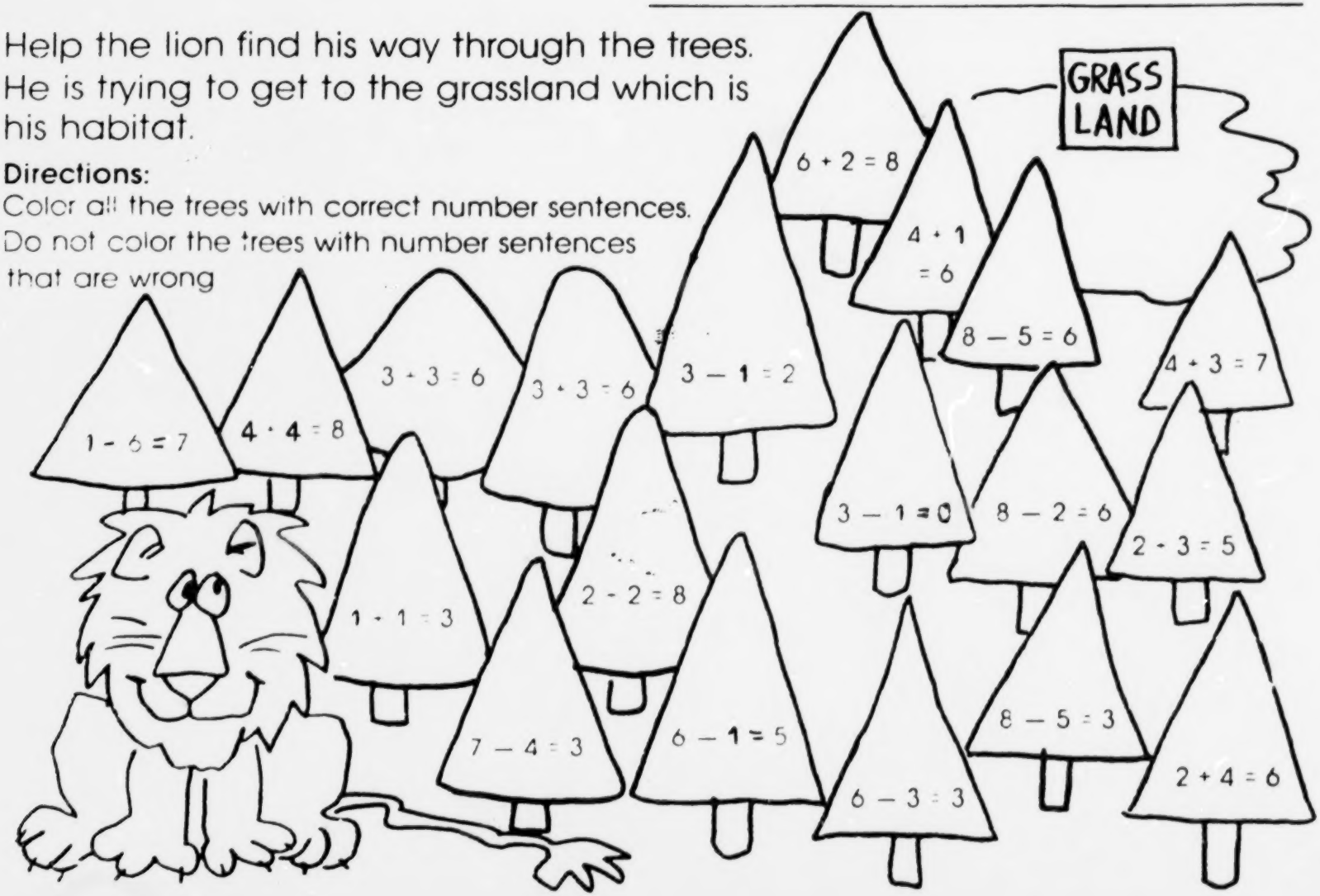
Litter along our highways and on our playgrounds is an ugly sight. We must do our part to keep litter off the roadside, out of our campgrounds, and in the wastebasket. You can help by making and using a litterbag for your car.

Color the picture. Cut it out and paste it on a small paper bag. Put the bag in your car to hold your litter.

Name _____

Help the lion find his way through the trees. He is trying to get to the grassland which is his habitat.

Directions:
Color all the trees with correct number sentences. Do not color the trees with number sentences that are wrong



Green Schools
The Sacramento Tree Foundation

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PLT

Adopt-A-Tree

OBJECTIVE

Students will be able to list the basic characteristics of a tree as determined by their own observations.

ACTIVITY

This activity may be conducted as a class project; with a class divided into groups of three or four students each; or with students working individually. Several related activities are included in the pages that follow. They are indicated by Adopt-A-Tree in the titles.

This activity begins with adopting a tree (or trees) near or on your school site. If there are no trees nearby you might bring a potted tree to your classroom or try to have a tree planted on the school grounds. "Adopting-a-tree" is a valuable way to initiate a unit of study on trees with any age group.

The first visit

Visit the adopted tree(s).
Describe the tree as it is right now, today.
Look at its physical characteristics (size, leaf shape, bark color, and other features).
Look to see whether it is alive. How can you tell?
Look to see whether it appears to be asleep (dormant) or awake. How can you tell?
Listen to find out whether it makes any sounds.
Smell to find out whether it has an odor. Do different parts of the tree smell different — like bark, old leaves, new leaves? Think about whether the tree and its parts might smell different to you at other times of the year.
Think about how the tree got where it is and how new trees might come to join it.
Think about what other living things might need this tree for survival.
Think about what things the tree might need for its own survival.
Think about how long the tree might live.

Warning: Do not taste any part of the tree.

Repeat the visits throughout the year and compare observations made each time.

Look to see how the tree has changed.
Look to see in what ways the tree has remained the same.
Think and talk about what the tree might look like the next time you visit it.

SUBJECTS
- Language Arts and Humanities
- Science

GRADES
- K-6

PLT PRINCIPLES
- 1. Environmental Awareness
- 2. Diversity of Forest Roles
- 5. Cultural Contexts
- 6. Life Support Systems
- 7. Lifestyles

CONCEPTS
- 1.1 Variety and Aesthetics Essential to Life Support
- 2.112 Forest as Resource Pool
- 5.42 Environmental Perspectives
- 6.2 Constancy of Biological Change
- 7.4 Creative Expression and the Environment

SKILLS
- I Gaining Information
- II Communication

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(Continued)

2. Create and present a short story, puppet show, or play about the tree's parents and/or its offspring.

3. Imagine sounds you might hear near the tree. Can you hear leaves moving, animals, birds? Write a brief description of these sounds, inventing appropriate words, if necessary. Imagine you are looking at the tree. What colors and shapes do you see? Write a brief description, using your new words, of how the tree looks, smells, feels, and sounds.

4. Write a brief, imaginary conversation with your tree. What might your tree think, see, feel, hear, and smell? (You may wish to record the conversations on tape.)

5. Imagine you are a radio or television reporter interviewing a person, bird, or animal that lives in a forest or in a tree. Write down some questions you might ask, such as: How do you like your home? Who are your neighbors? What do you do for a living?

6. Take a tree to lunch. During lunch, consider these and other questions:

   What is it like under the tree?
   What animals visit the tree while you are there?
   What kind of help is the tree getting from people, if any (watering, feeding, pruning), and does it need that help?
   Why and when does it need help?
   What kinds of things, if any, are damaging the tree?
   Has the tree cast seeds? Have any seeds developed into seedlings?
   How does the tree take care of itself?
   How much of its history can you observe? Has it had any accidents (such as being hit by lightning)?
   Is the tree crowded by other trees or by buildings?

7. See whether your tree makes a shadow. Watch the changes in your tree's shadow at different times of the day and during different times of the year.

8. See whether you can use your tree, without hurting it, to make a sundial. Can it help you keep time?

9. Make paintings, drawings, or photographs of the shapes and shades of color you find when sunlight and shadows can be seen on and around your tree.

10. Describe your tree in enough detail so that someone else can recognize it. Share what you have learned by inviting someone else to visit your tree — and be sure to visit your friend's tree, too.

(Continued)

After the first or more visits

Once back in the classroom and now that you and your students have adopted a tree, you might ask your students to tell you what they think a tree is. Accept all statements offered and be careful to record the students' exact words and phrases. List the statements on the chalkboard; discuss and make any changes suggested. When statements have been agreed upon, you and the students can put them together in the form of a poster, chart, or bulletin board.

Here are some sample statements:

A tree is a living thing.
A tree has many parts, just as people have many parts to their bodies.
There is the trunk (main torso), bark (skin), branches (arms, legs), leaves or needles (hair).
Trees have names. [The children can mention some names of trees.]
A tree has many uses. [You and the students may wish to list some.]
A tree interacts with and is dependent upon many other organisms, such as insects, mammals, and birds.

These initial activities can help you decide on follow-up projects by indicating what the students already know, what their interests are, and the kinds of additional information they might acquire.

EXTENSIONS

1. Brainstorm from 10 to 15 adjectives that could be used to describe a tree. These words can be used to write a poem (haiku or cinquain) or short paragraph about the tree.

Tree Collage

Each child makes a tree collage, (the use of different objects to form a tree), pastes it onto a large piece of poster board and writes a poem about trees to accompany the collage.

Materials:
Objects collected from nature such as, bark, pine cones, leaves, needles, twigs, flowers, etc. Construction paper, glue, paint, crayons, pencil and poster board. Pictures and words from magazines may also be cut out and used.

Instructions:
1. Have children gather objects from nature, either on their own or on a class trip.

2. Have each child make a large tree out of construction paper. The tree is then be pasted onto a piece of poster board. If you prefer, the trees may be painted directly on the poster board. The child then pastes the collected objects onto the tree.

3. Finally, have the children write a poem about the trees they have created or about trees in general.

Use simple questions to spark their development of the poems: Why do you like trees? What fun things have you done around trees? Why are trees important to children? To animals? What is special about the tree you just created? How do trees benefit the community and the environment?

Suggestions:
1. Have students model their trees after California native trees.
2. Post he tree collages in the classrooms in honor of trees.
3. Research the different types of trees and animals in other parts of the world.
4. Discuss trees and their importance to humans, other animals and the planet.

ALPHABET HUNT

Take along on your field trip a clip board, a pencil and this activity sheet. Find objects and animals in nature that begin with each letter of the alphabet.

Classroom variations: From memory, list objects and animals in nature or list things that people can do to help the planet earth.

A_____ M_____

B_____ N_____

C_____ O_____

D_____ P_____

E_____ Q_____

F_____ R_____

G_____ S_____

H_____ T_____

I_____ U_____

J_____ V_____

K_____ W_____

L_____ XYZ_____

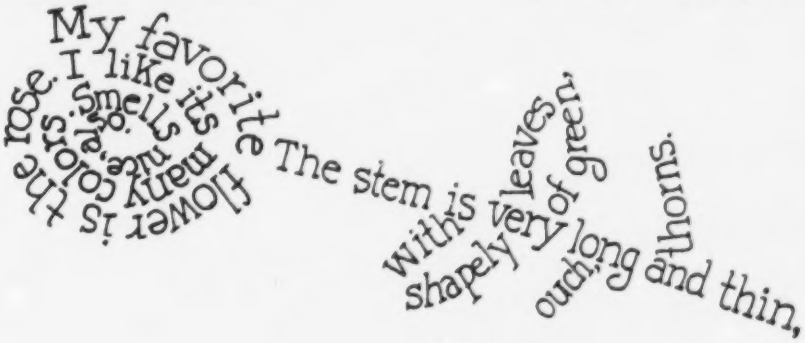
"Picture Your Thoughts" . . . creative writing

WHAT YOU NEED: Paper, pencil, crayons, and a headful of thoughts!

WHAT YOU DO: Choose something from a garden scene that you would like to draw and write about. It could be trees, grass, flowers, insects, or bushes. Begin writing about your subject and as you write, shape your sentences into the form of your subject. Write whatever comes to your mind and turn your paper about as you continuously "draw" your subject! You might want to use crayons and change colors along the way.

More Fun Projects

- Make up stories on how beans got their names . . . kidney, lima, pinto, and string bean. Include imaginary illustrations.
- Keep a dictionary of vocabulary words common to planting experiences.
- Write your own cinquains. Follow this form: Line 1-one word (title), Line 2-two words (describe), Line 3-three words (action), Line 4-four words (feeling), Line 5-one word (a title substitute).
- Try some Haiku, too! line 1-five syllables, Line 2-seven syllables, Line 3-five syllables.



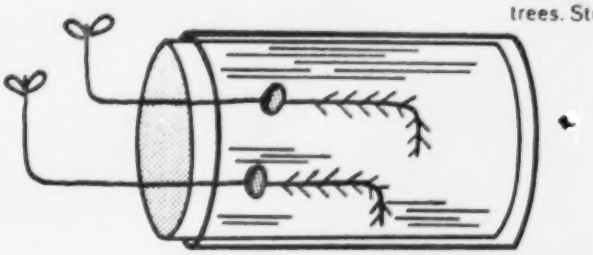
"What's your angle?". . . gravity

WHAT YOU NEED: 10 radish seeds, a glass jar, paper towels, and water.

WHAT TO DO: Soak your radish seeds and place them in a glass jar that is lined with wet paper. Grow the seeds in the dark until the stems are about 1 inch long. Pour off the excess water from the jar and turn it on its side. Keep it in the dark. Wait 24 hours and notice the growth of the stem. Now turn the jar right side up. Put some water in again and leave it in the dark for 24 hours. What happened to the stem now? What does this experiment tell you about the growth of the stem? How about the growth direction of the roots?

More Fun Projects

- Dissect a seed or flower. Identify and label the parts.
- Experiment with "phototropism". Cut down one inch square at one end of a shoe box. Fill with gravel and top with soil two-thirds high. Plant bean seeds. Water to moisten, and cover the box with the lid. Do not peek except to water. In a week, watch how the new plant will be bending toward the patch of light at the opened end!
- Experiment with dyes from the leaves and skins of various vegetables.
- Investigate the different methods of collecting sap from trees. Study its many uses, too!



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LESSON I: WHAT IS A TREE

Objectives of this Lesson:

After this lesson, the student will be able to:

—Recognize trees as a specific form of plant life and be able to identify the three main parts.
—Compare and contrast trees and people.
—List some interesting and unusual facts about trees and other living things.

Materials:

—Poster: How a Tree Grows - U.S. Forest Service
—Poster: Life, Death, and Rebirth of a Tree - U.S. Forest Service
—Blackboard, chalk
—Writing paper and pencils
—Tree branches (optional)

PART I - Definition of a Tree: Roots, Trunk, and Crown - Background Notes:

A tree is a large woody plant. It usually has a single woody stem or trunk and branches. It grows at least 15 feet tall. When fully grown, it has a well-defined crown or tree top.

A shrub is also a woody plant, but it is different from a tree in the following ways. A shrub has several stems. Usually it is less than 15 feet tall. Shrubs form a dense clump and do not have a well defined crown. Sometimes the distinction between a tree and a shrub is difficult to tell. Many single stemmed plants are less than 20 feet tall and are still considered trees, however, we usually call them "dwarf" trees.

Trees are made up of three main parts: Crown or tree top, trunk, and roots.

Crown: The upper part of the tree which bears branches, leaves, flowers, and fruit. People also use the word crown to describe the place where the trunk and root join - the "root crown".

Trunk: The trunk can be thought of as a cylinder filled with pipes and a solid core. The trunk supports the tree upright. The trunk gets thicker each year.

Roots: Roots anchor the tree. The root hairs at the end of roots absorb water and minerals and transport them to other parts of the tree. Roots help hold soil in place and prevent erosion. Roots store food for the tree. Roots hold the trunk and crown upright. The roots may spread further than the branches.

Activity:

Ask the students to discuss their definition of a tree. List their statements on the blackboard. After discussing their thoughts about trees, give them your definition. Using the How a Tree Grows poster, show and discuss the three main parts of a tree. (The functions of the leaves and other tree parts, and the inside of a tree and how it grows will be discussed in Lessons II and III.) Have the students draw a picture of a tree and label the crown, trunk, and roots. Give a brief definition of these parts. The students will have a chance to use this information in a hands-on way during the "building a tree" activity of Lesson III.

Alternate Activity:

Teach the students the definition of a tree. Discuss the three main tree parts and their functions. Ask the students to compare these tree parts to an apartment house. Put the following chart on the blackboard or duplicate it on a handout and have the children fill in the blanks.

Trees are like apartment houses:

Apartment House	Comparable Part of the Tree	What Happens in Them Both?
Roof and upper floor		
Windows and solar collectors		
Floors in between		
Foundation and basement		

Background notes for this activity: The roots are like an apartment's foundation, giving it support. Roots store things like a basement.

The trunk is like the framing supporting the building. The trunk supports branches and leaves. It also holds food inside, like an apartment holds people. A tree has pipes to carry water like the plumbing in an apartment. Or looked at another way, the trunk provides transportation from the roots to the leaves like stairs take people to the top floors of the apartment. Holes in a trunk are like the individual apartments in a big building. The holes provide homes for many types of birds and animals, like squirrels and raccoons.

The tree crown can be thought of as the upper floors or top story of the apartment. This is where birds and certain insects live. Some birds, like hawks and owls, use the tree top as an observatory to watch for their next meal. The crown also acts like a roof to shade and protect the animals and insects living within the branches. Some apartments have solar collectors on their roofs which capture sunlight and change it to energy. Trees have solar collectors too - leaves!

Questions for Discussion:

a. What are some things the crown of a tree provides?

   A home for birds and squirrels, a canopy of shade, a place for fruit to grow.

b. If you planted a tree too close to a sidewalk, what problems might occur?

   Roots are very strong and because they grow thicker every year, they might break the concrete.

c. What might happen to a tree if the roots were cut?

   The tree might blow over or not be able to take in enough water to supply the leaves. The tree might die, if too many roots were cut.

PART II - Trees are Living Things - Background Notes:

Trees have both similarities and differences to people. Like people, trees need food, water, oxygen (air), and sunlight. They grow in height and width. They need nurturing and special care. They grow old and die. Unlike people, trees cannot walk, see, hear, or talk (but doesn't it sometimes sound like trees are talking when we hear their leaves rustle). They cannot heal wounds, but they do have special ways of closing off wounds and protecting the inside from diseases and insects. When wounded, trees can sometimes grow new parts, like branches, to replace the old damaged ones. People cannot replace limbs when they are lost. Trees do not have eyes. They have chloroplasts. These organs for photosynthesis react to light and operate in ways similar to our eyes. Trees must have food for energy. Trees do not eat food, they make their own from sunlight. People cannot make food. Without trees and other plants making our food and food for animals we eat, we would starve. Trees do not have blood, but they do have a special fluid inside them called sap that is as important as blood. When sap leaks out of a cut, we often call that "bleeding". Trees cannot choose where they want to live in the city. We choose where to plant them and how to plant them. Trees often depend on us to water them, provide them with nutrients, and see that they are protected. They are like tiny babies — they need help, especially in the city. In the forest, they do a pretty good job of taking care of themselves.

Activity:

Ask the students to think of things about trees that may be similar to them. Then have them discuss what is different about them and trees. Add anything they may not have mentioned. Use the Life, Death, and Rebirth of a Tree poster to show the life cycle of a tree. Point out the similarities between people and trees as well as the differences brought out in the poster.

Alternate Activity:

Bring in several branches from trees. (Be careful in selecting the branches. Take them only from trees you have permission to and be sure you don't injure the tree when cutting them. A tree that is being pruned is a good source.) Pass them around to groups of children. Tell them they are looking at something that is alive. It breathes, uses sun to make food, gives oxygen so we can breath, etc. Ask them to discuss how trees are the same as they are and how they are different.

Questions for Discussion:

a. Are all dead trees bad?

No.

b. When would they be bad?

If they were rotten and there was a danger of them falling.

c. When might they be beneficial? How so?

Dead trees provide shelter for certain animals and birds like woodpeckers. As they are rotting, nutrients are returned to the soil, and food is provided for insects and other decay organisms.

PART III - Tree Comparisons - Background Notes:

A tree is more than just a woody plant. It is a living organism. A tree can be compared to other living things.

Largest - Trees are the largest (heaviest) living things. California has the largest tree. (This was determined from a boring taken in 1931.)

Land Animal - Elephant, 12' tall, 24,000 pounds. One bull elephant was seen in 1965 that was taller than 12'. It was given the name Zhulamiti "Taller Than The Trees".

Sea Mammal - Blue Whale, 100' long, 150 tons.

Tree - Sequoiadendron gigantea - Big Tree - General Sherman in Sequoia National Park is 32.2 feet in diameter. It weighs 1,190 tons and is said to be 3,000 years old. (This was determined from a boring taken in 1931.) Its cone is only 2-1/2 inches. The wood in the big tree is enough to build 40 five bedroom houses.

Man - 1,069 pounds; Woman - 850 pounds. Most people weigh much less than this.

Tallest (or Longest) - Trees are the tallest living things. California has the tallest tree.

Longest Animal - Jellyfish - 245'

Longest Sea Plant - Kelp, 300'

Tallest Animal - Giraffe, 19'3"

Tallest Tree - Coast redwood - Sequoia sempervirens - in Redwood National Park - The H. A. Libbey tree is 367' tall. (It is 2,200 years old.) Its cone is only 1". Tallest conifer besides Sequoia - Nobel fir in Washington State is 278' tall. Tallest tree ever was a Douglas Fir from Washington State that was 385' tall and 14-1/2' in diameter. It fell over in 1825.

Man - 8'11"; Woman - 7'5"

Oldest - Trees are the oldest living things. California has the oldest tree.

Mammal - Killer whale, 90 years.

Land Mammal - Asiatic elephant, 69 years.

Animal - Box turtle, 129 years.

Tree - Bristlecone Pine - Pinus aristata - 5,000 years old. Sierra Redwood - Sequoiadendron gigantea - the General Sherman is positively 3,200 years old, and may be 4,000 years old.

Man - 114 years; Woman - 113 years. There may be older people, but their age cannot be confirmed.

Sacramento's Oldest and Largest Trees:

In 1933, a contest was held to find the largest oak: A Valley Oak - Quercus lobata - 258" around, or almost 7 feet thick at its base. Some other big oaks that won in their categories were a 219" interior live oak - Q. wizlizenii; an oracle oak - Q. morehus - a cross between the California black oak and an interior live oak, at 157"; and a 184" blue oak - Q. douglasii.

Sacramento's oldest planted tree is probably the Fremont cottonwood - Populus fremontii - at Sutter's Fort. It may be 130 years old. The exact origin and age is vague. One account claims the trees were present prior to John Sutter settling the fort in 1839. Another source states that John Sutter, Jr. placed two sticks in the ground after having used them as survey stakes when laying out the streets of Sacramento in 1849 and they grew into the two cottonwoods (one blew over a few years back). A third account by Miss Lillie Blue in 1942 suggests that her uncle Elihu Cross, a resident of the fort, planted the trees in 1852.

Activity:

Ask students what they think are the largest, tallest, and oldest living things and how old, tall, or large are they. Discuss the above statistics. You may wish to show slides of redwoods and bristlecone pines and where they grow.

Questions for Discussion:

a. Redwoods grow in Sacramento. Why don't they get as big here as in their native habitats?

   Because the climate and environment here is different than along the coast.

b. Why don't city trees live as long as trees in a forest?

   They have to put up with smog and other chemicals. They are crowded by buildings; the soil does not have as many nutrients because the leaves are raked up; their trunks are injured by cars, bicycles, and people hitting them; their roots are crowded into small spaces, so water penetration is restricted.

LESSON II: HOW A TREE GROWS

Objectives of this Lesson:

After this lesson, the student will be able to:

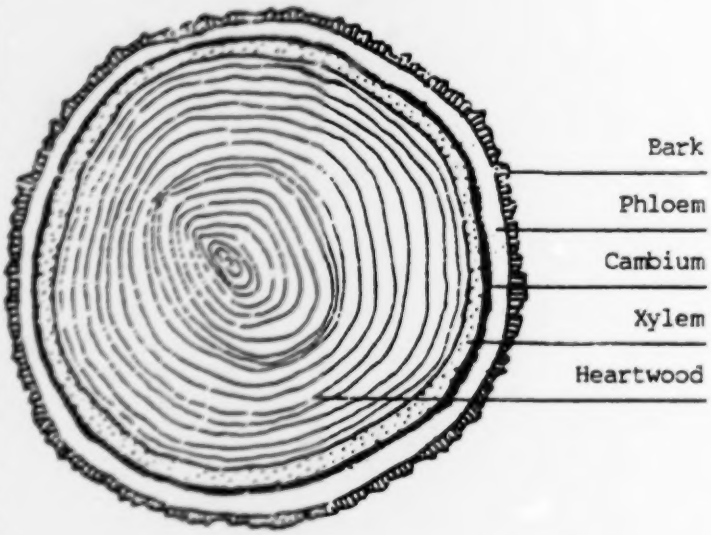
—Discuss the functions of the cambium, xylem, and phloem.
—Explain what happens when the bark of a tree is cut or injured.
—Count the rings on a tree to tell its age and a little about its history.

Materials:

—Poster: How a Tree Grows - U.S. Forest Service
—Poster: How a Tree Grows - Ortho (May use USFS one by itself)
—Poster: The Trunk of a Tree - St. Regis Paper Co.
—Poster: The History of a Tree - St. Regis Paper Co.
—Tree branches (optional)
—Leaflet: The Life of the Forest - St. Regis Paper Co.
—Cross Section of trees or pictures of cross-sections

PART I - How a Tree Grows/Tree Plumbing - Background Notes:

Heartwood - Central support of the tree. Old non-functional xylem (sapwood) cells. It's often dark in color due to resins. Gives the tree strength. If destroyed, the tree can still be alive, but is structurally weak. Although the heartwood does not function and is often thought of as dead, it will not decay or lose strength while the outer layers are intact. Heartwood is held together by fibers called lignin that is in many ways as strong as steel. A piece of 1" long and 1" by 2" in cross section, set vertically, can support a weight of twenty tons.



Xylem - also called sapwood, is the tree's waterproof and rotproof pipeline for carrying water and dissolved minerals, such as nitrogen from roots to the leaves. Produced by the cambium, sapwood is the new wood. As newer rings of sapwood are laid down, its inner cells lose their vitality and turn to heartwood. The accumulation of xylem causes the trunk to increase and this becomes wood. In the spring, sap (sugars and starches) that has been stored in the roots over the winter is transported up the xylem to newly developing leaves. Thus, xylem is also called sapwood. This sap is particularly high in sugar in some trees, like maple. When properly processed, this sap makes maple syrup. On a warm summer day, a large tree takes up to 150 gallons of water from the soil. Mistletoe is a parasite (an organism that lives on or in a living plant, at the expense of that plant) that sends its haustoria (root like fungal strands) into the xylem of trees and robs the tree of water and minerals.

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Cambium - The cambium is actively dividing tissue (called meristematic), one cell thick, that produces phloem and xylem. The result of the activity of the cambium is that a tree can add new wood for hundreds of years - or thousands, as in the case of the redwoods. If all the cambium is destroyed, the tree dies.

Phloem - also called inner bark, is the pipeline that carries sugar made in the leaves down to branches, flowers, fruit, trunk, and roots, where it is converted by enzymes to form new products. The sugar, when broken down, is then recombined with nitrogen and other minerals to form substances like starches, fats, oils, and proteins. Sugar is also converted to make cell-wall substances such as cellulose, lignin, and subertin which make up wood and bark. When a sucking insect, like an aphid, feeds on the leaves or twigs of a tree, it sticks its mouthparts into the phloem. The sticky substance that exudes from the aphid's body is excess plant sap, called honeydew. The older phloem becomes crushed by the expansion of the xylem, thus, while there is a massive accumulation of xylem in trees, there is little more than a year or so of phloem present. If you were to scrape the bark of a young twig, you would see a green, slick tissue underneath. You are looking at the new sapwood and possibly the cambium and phloem. The cambium and phloem tissues are so thin that they are difficult to see by themselves.

The phloem, xylem, and cambium tissues collectively are called vascular tissue.

Bark - As the phloem disintegrates, it becomes bark. The phloem, corky tissues, and other incidental tissues form the bark. Bark is like a special skin. It protects trees from injury by animals, insects, diseases, excessive heat, cold, dryness, etc. Bark is continually renewed from the phloem. When bark is injured, it opens up the tree to all kinds of problems.

The reason a bark cracks, peels, and splits is because newly formed living cells of bark (phloem) can adjust themselves to the expansion by the cambium, but the dead outer bark (cork) can't. The bark then splits into long cracks or ridges, pines and oaks; or peels off in stripes or patches, birches and sycamores.

On the surface of the bark there are often small dots or streaks. These are called lenticels. They are masses of cells produced within the bark which break through to the outside. The lenticels make it easier for the inner bark to obtain oxygen. Also, excess water vapor and carbon dioxide are given off. In most trees, the roughness of the bark obscures the lenticels, although they are present.

Girdling - Cutting into a tree injures the bark, and if the cut is deep enough, it can kill the phloem, cambium, and xylem tissues, leading to death of the tree. Let's see what happens to a tree if a wire is fastened to its trunk. As the tree grows, the wire cuts into the bark. Because the phloem is so near the surface, it is killed first. If the phloem is killed all the way around the trunk, food coming down from the leaves can't go past the dead area. The roots begin to die from starvation. The dying roots can't transport water to the top so the tree dies for lack of water. If the wire does not cut the phloem all around the trunk, the tree may be able to survive on the phloem that remains. If the wire cuts too deeply, the tree will die fairly quickly as no new xylem or phloem can be made when the cambium is destroyed. The tree starves and dries out. Sometimes it takes up to two years for a girdled tree to die because it is living off stored food.

Activity:

Using the How a Tree Grows poster, discuss in detail the parts of a tree and their function. You may wish to bring in branches to show the bark, phloem, cambium, and xylem more graphically than what the poster can do alone. Another way of demonstrating the real life applications of the effect of girdling on a tree is to show slides of trees that have had stakes and tree ties left on too long.

Questions for Discussion:

a. From where do we get real maple syrup?

It is the sap from a special tree, the sugar maple, Acer saccharum, found growing in the Eastern United States. Sap is food made by the tree, which is stored in the roots over the winter and moves up the xylem in the spring. A tap is placed in the tree to release the sap.

b. What would happen if someone was to carve their initials in the trunk of a tree?

It depends on how deep they go. If it were real shallow, the wound would probably close or callus over fairly quickly. If it were too deep or big, however, the inner tissues might be killed and this could bring in decay or insects. The tree's "pipelines" for carrying water and sugars might be injured enough to slow down the flow which would slow down the tree's growth.

PART II - Annual Rings Tell the Age and History of a Tree - Background Notes:

As the cambium adds new xylem cells each year, the tree gets larger. This wood growth is called an annual ring.

Trees usually have good growth conditions in the spring. Cell division in the cambium is rapid. Fast growth continues until lack of moisture or hot temperatures slow it down. Through the summer, cell division in the cambium continues, but at a slower pace. This change in how fast the tree grows each year is what causes the two parts of the growth ring: The springwood (or earlywood) is formed during the early, rapid growth period. It is less heavy or dense than the summerwood (or late wood). The greater density of the summerwood is due to thicker cell walls. Due to its greater density, the summerwood usually is darker in color than the springwood. In some species, the annual rings may be very difficult to see. This is because their springwood and summerwood look very much alike. Examples are poplar, alder, and cottonwoods. These trees grow where there is an ample supply of moisture. By counting the dark rings of a tree you can tell the age of a tree and some things about its history.

Activity:

Pass out cross sections of trees. Use polished ones that make the rings easy to see. Try and get sections from trees or large branches that are at least 15 years old. Define a tree cross-section. Show the students how to count the rings to determine the age of the tree. Starting from the bark edge, have them count back to the year they were born. Ask them to determine how old the tree

was then. Explain any environmental conditions that can be seen in the cross sections. Explain how periods of stress show up in the rings. (The rings will be narrow and appear crowded.) Explain that the age of a tree can be determined without cutting it down by using an instrument called an increment borer: A tool that removes a small core from the tree without injuring the tree. This is how the age of the coast redwoods and bristlecone pines were determined.

Alternate Activity:

If sections of trees are unavailable, use the History of a Tree poster or pass out pictures of a cross section of a tree such as the one found in the Life of the Forest leaflet.

Questions for Discussion:

a. Why are some year's rings of a tree narrow and other year's rings wide?

It is usually caused by variations in rainfall. In drought years, the tree does not grow as much and the rings are narrow. When the tree gets plenty of water, the rings are wider. Trees like cottonwood, alders, and willows growing near water always have very wide growth rings that are hard to tell apart from year to year.

b. What part of the tree ring is the youngest? Which is the oldest?

The youngest is the ring near the outer edge. The oldest is the center ring.

c. Some tree rings look lopsided. What causes this condition?

The tree grew on one side more than the other side. This is due to something that hindered growth, like another tree or a building shading or crowding the tree.

LESSON III: TREE SEASONS AND CYCLES

Objectives of this Lesson:

After this lesson, the student will be able to:

—Discuss what happens to a tree during the four seasons.
—Explain how seeds are formed in a tree.
—Distinguish between a conifer, broadleaved evergreen, and a deciduous tree.
—Write a simple formula for photosynthesis and explain its importance to the tree and to them.
—"Build a Tree" and act out its growth and seasonal cycles.

Materials:

—Poster: The Grand Cycle of Life - Ortho
—Poster: Autumn Color Changes in Trees - St. Regis Paper Company
--Twigs with buds, cones, seeds, fruits, and green and colored leaves (For a more hands-on approach to this lesson, bring in these tree parts to use as examples when discussing them during the various activities.) (optional)
—Tree cards for 'build' a tree activity

PART I - A Year in the Life of a Tree - Background Notes:

Trees grow and change through seasons:

Spring - buds swell, leaves emerge, flowers bloom, fruits begin forming, and trunk grows thicker. A bud is a swelling on a plant stem, leaf, or root that gives rise to shoots, leaves, and/or flowers. Any bud is a potential length of stem with leaves. At the start of their growth, leaves and flowers are kept inside little protective buds. The buds are covered with overlapping bud scales to protect the delicate leaf from drying out or getting too cold. The buds are located on twigs. Twigs have a fat terminal bud and several side buds. In the spring, the newly opening leaves push off the bud scales and open up so they can capture sunlight. Trees grow in height only from special cells located in buds near the ends of twigs and branches.

Summer - leaves become a deeper green, branches lengthen, fruit ripens, some trees bloom now (crape myrtle, Japanese pagoda, albizia), and near the end of summer next year's leaves and blooms begin forming in buds.

Fall - some fruit and nuts ripen (persimmon, apples, walnuts), leaves of deciduous trees turn color and drop, and seed pods show.

Winter - bare branches, except for evergreens, no obvious growth, however, roots continue to grow as long as the soil is not frozen. This period of inactivity is called dormancy. A few trees flower in late winter, like the white alder which produces catkins in January and the silver maple with their tiny red feathery flowers in February.

Activity:

Follow one type of tree, such as an apple, through the year. Discuss changes that take place during the seasons. The poster, The Grand Cycle of Life, can be used for this purpose. Explain that buds are where new growth on a tree begins.

Questions:

a. If a swing was hung from a tree branch four feet from the ground, and the tree grew two feet that year, at what height would the swing be the next year?

The same. A tree only grows taller from the ends of the branches. Once a branch is in a position, that is where it will remain. That is why it is important to prune low limbs off when the tree is young. In the future, they might interfere with pedestrians or cars, since they cannot move.

b. What would the consequences of a cold winter be on the buds of a subtropical tree like a citrus or avocado?

They are not adapted to very cold temperatures and would probably be severely damaged or killed.

c. If the buds were killed, what result would this have on the tree?

Since all growth comes from buds, leaves might not emerge, stems might die, and few or no flowers would be produced.

PART II - Leaves: Nature's Food Factory- Background Notes:

Leaves are very important to a tree. A tree breathes and feeds with its leaves. Leaves are a tree's manufacturing plant. Trees make their own food by a process called photosynthesis. Photosynthesis = manufactured by light. Leaves absorb sunlight and carbon dioxide from the atmosphere and convert it to food for the tree. This process gives off oxygen. The chemical formula for photosynthesis is $6H_2o + 6CO_2 \text{-----}> c_6H_{12}O_6 + 6O_2$ (Six molecules of carbon dioxide combine with sunlight to produce glucose [sugar] and oxygen. The water comes from the leaf.)

Without photosynthesis, our atmosphere might have vast amounts of carbon dioxide (released in volcanic eruptions) and virtually no oxygen - as do the atmospheres of Venus and Mars. (They do not have plants.) Without trees and other plants, there would be no life. We could not breath and would not have food to eat. Inside the leaf are green pigments called chlorophyll that actually do the job of absorbing sunlight. The chlorophyll is carried in small bodies in the protoplasm of cells called chloroplasts.

Do not confuse the food a tree makes for itself and fertilizer, which is often called "plant food". Fertilizer does nourish the plant by providing essential minerals, like nitrogen, phosphorous, potassium, iron, zinc, and others, that the soil is lacking, but it is not food. Only plants make food.

Transpiration: Excess water taken up by the roots moves out of the plant via the leaves. The loss of water through the leaves and into the atmosphere is called transpiration. Water is lost through small openings or pores in the leaves called stomata. Stomata open and close to let air in and out and water out. Leaves 'breathe' through their stomata. When a plant does not have much water, the stomata can close, thus reducing transpiration and conserving water within the plant.

Some trees have leaves all year, they are called evergreen. Trees that lose their leaves in the winter are called deciduous. Some evergreen trees have leaves that are long and narrow, like pines, these are called conifers (cone bearers). Evergreens with broad leaves are called broadleaf evergreens. Carob, magnolia, camphor, and eucalyptus are broadleaved evergreens. Evergreen trees do not keep their leaves forever. They are replaced after about three years, but since they are replaced gradually, the tree appears green all year. But check the ground below trees like pines, and you will see the old needles which have fallen as new ones took their place.

Why Leaves Turn Color and Drop: Deciduous trees and shrubs often show bright colors just before leaf drop in the fall. A leaf is a small plant factory using sunlight to make food needed for plant growth (photosynthesis). As the days become shorter and temperatures cool, this leaf factory gradually "closes down". Leaves do not fall simply because they are dead. A zone of cell division called the abcission zone (a layer that separates the leaf from the twig or petiole) develops near the base of the leaf. Materials like pectins and cellulose are formed in this area. These materials dissolve the cell walls as the abscission layer is forming and water cannot get in or out. As the leaf runs out of food and water and as temperatures drop, the leaf stops making chlorophyll.

Chlorophyll hides other colors - chlorophyll, the green coloring in the leaf, hides other colors during the growing season. When the leaf stops making food, the chlorophyll is gradually destroyed and other colors appear. These other colors are known as anthocyanins (reds, scarlets, vermillions) and carotenoids (yellows, oranges, reds). In time, these colorful components of leaf cells are also destroyed to reveal brown tannins which are the most resistant to chemical destruction.

Not frost - contrary to popular belief, a frost does not cause a change of leaf color. A light frost will often speed the destruction of the green chlorophyll. However, a heavy frost can destroy the chlorophyll and the other colorful pigments so that the leaves appear brown. Bright autumn days and cool nights enchance anthocyanin formation. That is why certain years fall colors are exceptionally spectacular.

Activity:

Explain photosynthesis and illustrate it with a simple equation such as: sunlight plus water plus carbon dioxide (a gas in the air) plus green leaves produces tree foods like sugar and oxygen (another gas essential for people to breathe). Discuss the importance of photosynthesis and what might happen to people, animals, and earth if it did not occur. Talk about how trees "breathe" through transpiration.

Discuss the difference between evergreen trees and those that are deciduous. Give some examples of evergreen and deciduous trees found in our area. Explain the difference between broadleaved evergreen trees and conifers.

Discuss why leaves drop in the fall and why they turn color. If it is the appropriate time of year, bring in some leaves of different colors. The poster on Why Leaves Turn Color should be hung on the blackboard if samples are not used.

Questions for Discussion:

a. What happens to photosynthesis at night?

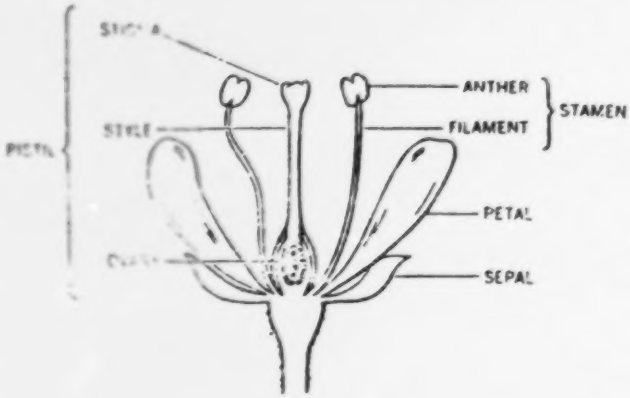
It stops because it must have sun to work.

b. Why does the Eastern United States have so many more colorful trees in the fall than we do?

Most of the trees that provide our area with fall color are native to the Eastern United States where they grow in abundance. Our native trees generally do not have good fall color. The Eastern trees we do grow here, like the liquidambar, tupelo, tulip tree, and red, scarlet, and pin oaks will give good fall color if conditions are right. Some of the Eastern trees, like the maple, that provide so much color do poorly here. Also, the Eastern United States has ideal conditions of cool, crisp nights and warm, milk days that induce the formation of the colorful pigments that turn leaves such brilliant colors. Our fall nights are often too warm and the days are too hot, so the pigments do not form or are destroyed.

PART III - Tree Facts of Life - Background Notes:

Flowers and Fertilization: Blossoms on a tree are not only pretty to look at, but where seeds for new trees form. Inside flowers there are male and female parts. (Flowers often have parts like petals and sepals, but these are not necessary for fertilization to take place. However, they do aid in attracting insects who then pollinate the flower.) The male portion is called the stamen, and it holds the pollen which looks like yellow dust. The female portion is called the pistil. This is where the immature seeds of ovules (sometimes called eggs) are found inside the ovary. (The ovary is found at the base of the pistil.) When pollen lands on top of the pistil (a process called pollination) it sends a tube down the pistil to the ovary where it joins with the ovules. This process is called fertilization. The fertilized ovules then grow into seeds.



Fruits: Seeds are protected by a covering called a fruit. (Botanically, a fruit is the enlarged ovary that surrounds the seeds. So, even vegetables like tomatoes, squash, and cucumbers are fruits in the botanical sense.) Some fruits are soft, like the apple, peach, or apricot. Others have hard coverings, like the walnut or almond. Each seed has its own fruit for protection. Ash and maples have a winged structure, called a samara, oak have an acorn, which is a nut, black locust and acacias have a long pea-pod structure called a legume and the fruit surrounding apple and pear seeds is called a pome.

Flowers and Cones: All flowering trees are known as angiosperms. All angiosperms have their seed enclosed in an ovary. Not all tree flowers look like a typical flower that has petals, stamens, sepals, and pistils, such as a peach or apple blossom. Some flowers are small and insignificant and are missing parts.

Not all flowers have both male and female parts. Some trees have two kinds of flowers. One flower will only contain the male stamens, while the other will hold the female pistil. Trees with male and female flowers on one tree are called monoecious, meaning one house. Alder and birch are trees with separate male and female flowers on the same tree. Alder and birch flowers (as well as oak, willow, cottonwood, and filbert flowers) are clustered together on a long, narrow, drooping structure called a catkin. Catkins appear in late winter before the leaves are open. There are a few trees that have the male and female flowers on different trees. These trees are called dioecious, which means two houses. In order to produce fruits on a dioecious tree, both male and female trees must be planted near each other. Of course, the male trees won't be able to produce fruit. Trees that are dioecious include pistache, ash, willow, and cottonwood.

Pollination: Some flowering trees are wind pollinated, while others are pollinated by insects (bees, moths, flies), birds, and bats. In Australia, there is even a nectar eating oppossum that pollinates eucalyptus. Insects are the most common pollinator, particularly honeybees. Flowers that are pollinated by insects are generally colorful and smell good. However, flies pollinate flowers that have a smell like rotten meat. Since moths have long tongues, many of the flowers they pollinate have their nectar at the base of a long floral tube. Bird pollinated flowers are colorful, with bright contrasts, however, they do not smell. Flowers pollinated by bats are dull in color, open at dusk, and have mouselike odors. The sausage trees, Kigelia, is pollinated by bats. It is found in tropical areas like Hawaii and some parts of Florida. None of the landscape trees in our area are bat pollinated. The wind can easily shake the pollen out of the dangling catkin.

Seeds: Once seeds are formed, they need to be transported away from the parent tree so they can start a life of their own. Seeds are moved in many ways. Ash, maple, and other trees have wings on them that fly through the air carried by the wind. The cottonwood has a fuzzy covering over the seed that makes it light and easily blown by the wind. Birds and animals carry seeds to new locations. Squirrels love oak acorn seeds, as do scrub jays. In September and October, the jays can be seen all over neighborhoods containing mature oaks pounding their acorn harvest into any attractive spot of earth, including lawns. They never seem to be able to find their buried treasure again, so the acorn sprouts and grows in its new found home. (Sometimes where it is not wanted.) Many trees have fruits eaten by birds who leave the seed behind to sprout and grow. People can also plant seed either intentionally or unintentionally, like when we spit out the pits (which is the seed) of a fruit we eat.

Seeds come in many sizes. Some are so small they look like specks of dust, others are quite large. The largest seed comes from a coconut. Giant trees like the redwood often grow from small seeds.

Activity:

Talk about flowers and their function. Explain what pollination is and how seeds are formed by fertilization. Explain the difference between flowering trees (Angiosperms) and conifers (gymnosperms). Talk about the role of insects and animals in pollination. Define a fruit. Give examples. It might be more effective if you could bring in several types of "fruit". Those that we think of typically as fruits and other non-typical fruits, like acorn, walnuts, almonds, or the winged fruits of the ash and maple. Explain that the seed is contained inside the fruit. Also, bring in cones from pines, redwoods, and other conifers. Choose different size cones for contrast. Have the students think of ways that tree seeds can be dispersed.

Alternate Activity:

Expand the section on flowers and reproduction to include planting a tree seed. Acorns from the native oaks and some of the planted exotic oaks are usually plentiful in the Sacramento area around September and October. Oaks would be a good choice, as they sprout readily and make good landscape trees. The Cooperative Extension leaflet, Plant Your Own Oak Tree #21334, could be used as a guide to the sprouting, planting, and care of the oak seedlings.

Questions for Discussion:

a. How might a bee pollinated flower differ from a wind pollinated flower?

The bee pollinated flower would need to have something, like nectar or colorful petals, to attract the insect. Wind pollinated flowers need a fairly large surface to contain all the pollen and must be out near the ends of the branches so the wind can blow the flowers, scattering the pollen. Thus, wind pollinated flowers are usually contained in catkins.

b. When do you think flowers pollinated by bats open?

At night, when the bats are active.

c. What is the function of the "fruit" or seed covering?

It protects the seed inside against drying out, insects, cold, mold, and injuries.

BUILDING A TREE

Hands-On Activity: To review and reinforce the concepts taught in Lessons I, II, and III.

The student will "build" a tree. Twelve to 35 students can participate. The students carry pre-made cards that identify what part of the tree they are representing. A leader (yourself) orchestrates the process one step at a time.

Prior to the lesson, make up a set of cards, 7" x 11". Use magic markers to write in the names of the parts of the tree and the environmental and cultural factors. You will need:

Roots - four plus	Branches - four plus	Tree Food (sugar) - one - Written on back of leaf card
Heartwood - one	Leaves - twelve plus	Woodpecker - one
Cambium - two	Sun - one	Wind - one
Bark - two	Oxygen - one	Energetic kid - one
Xylem - two	Water - one	Rope, wire, or tie - one
Phloem - two	Fertilizer (nutrients) - one	Flowers, fruit - on or more
	Carbon Dioxide - one	

Clear a space from the room large enough to handle the number of children that will be building the tree. Starting with the roots, ask a student to volunteer to come up and hold the root card. Place the student in the proper place for roots. Continue to build the tree asking the children to be additional roots and the other parts of the tree — heartwood, xylem, cambium, phloem, and bark. Have them assume their proper positions. It might help to have the "How a Tree Grows" poster placed where it can be seen. As each part of the tree is added, ask the children to explain that part's function. Next, add branches and leaves. After the tree is built, have the children act out the processes that take place in a tree. Have someone be the sun zapping a leaf. Bring in someone as carbon dioxide to work in conjunction with the sun. Have one of the leaves become tree food by turning over the leaf card. Ask the students to tell you what the process that just occured is called. The tree food made by photosynthesis should then go over to the phloem. The phloem takes the food and moves down the trunk stopping at the branches and finally making it to the roots.

Trees are affected by many environmental factors and have certain other needs. Have students be water and fertilizer being put on the roots. Have the xylem walk up the tree holding the water and nutrients cards, finally stopping at the leaves. Some of the water can escape the leaves through transpiration.

One student should act out a woodpecker hitting the bark (gently). Let the children explain what might be happening to the tree as the woodpecker puts holes in the bark. Have one of the children be an active kid hanging on limbs or hitting the tree. Again, ask what damage might be done to the tree. Some climbing in a large tree is ok. When would it be bad for the tree? Ask the child playing the rope or wire to wrap his/her hands around the tree and start squeezing. Ask the other parts of the tree what it feels like being strangled. Finally, the wind comes along and blows the tree down. All the children making the tree, fall on the floor.

Tree Seasons -

Once the tree is built, you might wish to use it to show the changes a tree goes through with the seasons. Starting with winter, have the leaves become very small to represent buds. Explain that these small buds contain next year's leaves. Act out the tree in spring. Have the xylem take sap stored in the roots to the ready-to-awaken buds. Have the leaves unfold from their winter buds. Attach flowers to the branches. Cones could be added instead of flowers to illustrate a conifer. Spring is when branches lengthen and thicken. Ask the students to act out this process. Follow the tree through summer: Fruit develops and ripens, the trunk expands because of the growth of the xylem, and next year's buds form. When fall arrives, all the leaves should fall off, unless the students have decided that their tree represents an evergreen. Ask the students to tell you what they call a tree that loses its leaves in the fall.

WOOLLY SUNFLOWER

DEER WEED

IDENTIFICATION GAME:
Getting to Know Sacramento's Trees and Plants

- Six or more children
- For ages 7 years and up

This game is a lot like Steal the Bacon, but has been adapted to help children identify and remember the trees and shrubs in our area. Begin by taking your group on a nature walk. As you explore the locale, collect small samples of leaves, flowers and seeds from the trees and bushes. You'll need at least 8 specimens.

Form two equal teams and line them up facing each other, 30 feet apart. Put the plant specimens in a row on the ground between the two teams. The teams count off separately, so that each player has a number, and on each team there are players numbered one, two, three, etc.

When the teams are ready, call out the name of a tree or bush represented by one of the specimens lying between the teams, then call out a number. (To add suprise, call the numbers out of sequence.)

"The next plant is a beech tree, and the number is....three!" As soon as the "threes" hear their number called, they race to the specimens, trying to be first to find the beech twig. Every successful player earns two points for his team. Picking up the wrong specimen results in a loss of two points.

The following few pages include descriptions of trees in the Sacramento area. For complete descriptions of local plants and wildlife, I recommend the book "Sacramento's Outdoor World, A Local Field Guide" available at the Effie Yeaw Nature Center.

Illustrations by Jo Smith.

GUM PLANT

COMMON YARROW

TELEGRAPH WEED

SPRING VETCH

DOG FENNEL or MAYWEED

HORSEWEED

PURPLE ASTER

WINTER VETCH

TREES

PINE FAMILY
Pinaceae

GRAY PINE or DIGGER PINE — *Pinus sabiniana*

This evergreen tree grows 40 to 65 feet high. It has a straggling, dried-out appearance. The gray-green leaves or needles are 3 in a bundle and droop from the branches. The cones are 6 to 10 inches long and nearly as thick. They have large recurved spines. The tree occurs in thin stands in the arid foothills.

Native Americans prized the oblong nuts which are rich in oil and proteins and are an excellent food. Cones were heated and knocked with rocks to release the seeds. These nuts were a valued trade item. They could be eaten or made into a soup for babies. The pitch served as glue and chewing gum and was used to heal burns and sores. Squirrels clean up the nuts nowadays. If you want to enjoy some of these nuts and have the patience, wait for a squirrel to gnaw off a cone for you. This may be a mean trick on the squirrel, but he can usually find another cone.

LAUREL FAMILY
Lauraceae

CALIFORNIA LAUREL or CALIFORNIA BAY — *Umbellularia californica*

This is an evergreen, aromatic shrub or tree growing from 15 to nearly 100 feet. Its bark is greenish or reddish brown. The shiny yellowish-green leaves are oblong or oblong-lanceolate in shape, 1 to 3 inches long and ½ to 1¼ inches wide. Small greenish-yellow flowers in clusters are followed by a round to oval fruit which becomes dark purple when ripe. The fruit and seeds are potentially dangerous and must be used with caution. However, a leaf or two gives a nice flavor to a stew. These make a safe insect repellent in stored flour or grain.

Native people used the pungent leaves in the steam bath for rheumatism and a smudge of the leaves to fumigate their homes. Leaves were also scattered on the floor to repel fleas.

In Oregon where this tree grows to its maximum height, it is called myrtle, and it is used to make highly polished bowls, lamp bases, and furniture.

Oleaceae

OREGON ASH *Fraxinus latifolia*

This deciduous tree grows 30 to 80 feet high. The leaves are about 14 inches long with 5 to 7 oval leaflets, light green on the upper surface with a broad, pale midrib. The veins on the leaflets are conspicuously curved near the margins. The winged seeds are 1 to 2 inches long, and hang in dense clusters. Oregon ash grows in the interior valleys of the Pacific Coast along stream banks and on creek sides.

Because hardwoods are scarce in the west, ash is in demand for interior finish, tool handles and furniture. The seeds are eaten by many birds and mammals. Beaver and deer browse on the twigs and foliage.

SYCAMORE FAMILY
Platanaceae

CALIFORNIA SYCAMORE *Platanus racemosa*

The sycamore or plane tree grows 40 to 80 feet high and the trunk grows from 18 to 30 inches in diameter. The branches are conspicuously irregular in the directions they take. They are thick, long and crooked. Some limbs practically lie on the ground with vertical branches growing up. The leaves are thick, 4 to 7 inches long and about as wide. They are somewhat like a maple leaf in form, light green above, lighter below, and very fuzzy. The sycamore's most distinctive characteristic is the very thin, smooth, whitish or pale green bark on young trunks and on the large branches of old trees. Thin sheets of the bark are shed annually as the stem grows. The dangling seed balls are approximately 1 inch in diameter.

The sycamore is found throughout the interior valleys and in the Coast Range watercourses. It loves the sun and is found near borders of streams and in most gulches. It grows in poor, rocky soil and forms sparse lines of growth. Sycamores are of ancient origin. Species now extinct were once common in Greenland and the Arctic during the Cretaceous period. The California sycamore was used as one of Sacramento's first street trees.

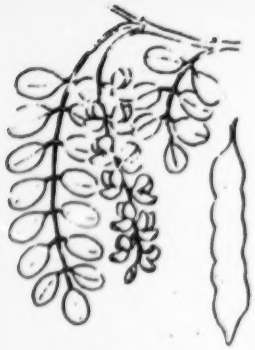
BEECH FAMILY
Fagaceae

BLACK OAK *Quercus kelloggii*

The black oak grows from 20 to 80 feet high scattered among the conifers on the lower slopes on the Sierra Nevada. The leaves are larger and more deeply lobed than the valley oak, and the lobes taper to one or more coarse teeth. The bark is dark and smooth, developing deep ridges, or checks, with age. Though uncommon in the valley, the black oak is conspicuous in the foothills in the spring with its new pale green leaves and in the fall with its colorful leaves contrasting with the dark evergreens.

ORACLE OAK *Quercus morehus*

Occasionally a cross between the live and black oak occurs. This hybrid oracle oak grows in scattered stands with other oaks, rarely more than two or three in one locality. It is an evergreen like the live oak with leaves resembling the black oak. It grows up to 50 feet high. Specimens may be found in the natural area at American River College.



PEA FAMILY
Leguminosae

BLACK LOCUST *Robinia pseudoacacia*

This slender tree grows 40 to 80 feet high. Erect branches form a broad head. The rough, dark gray bark is deeply furrowed. Compound leaves are 8 to 14 inches long. In April and May, white, fragrant flowers appear in drooping racemes. The brown seed pods hang on all winter. The black locust is not a native tree but came to the Sacramento region with the early settlers.

BIRCH FAMILY
Betulaceae

CALIFORNIA ALDER or WHITE ALDER *Alnus rhombifolia*

In the Sacramento area this plant grows along stream banks and is usually shrubby in appearance, seldom ever growing over 20 feet high. White alder leaves are 2 to 3 inches long, green and shining above and yellowish and fuzzy on the lower surface. The prominent midrib is yellow. Male flowers, long and in clusters, appear on the naked twigs in January. The female flower are in short spikes and, when the seeds mature, open to resemble miniature pine cones. This species often forms dense groves.

Native Americans used the inner bark to make a red stain for bows, arrows and trinkets. Yellow-brown and black dyes were also made from this tree.

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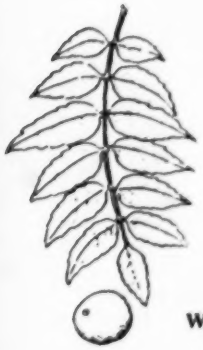
INTERIOR LIVE OAK *Quercus wislizenii*

The evergreen interior live oak grows from 25 to 80 feet high. It has a short trunk and stout spreading branches which form a round-topped crown. The older trees are full of great gnarled limbs. Foliage grows densely, making a solid silhouette against the sky. The leaves are flat, thick and leathery. The term dimorphic, meaning two different kinds of leaves, applies to the live oak. The leaf margins may be slightly indented and prickly, especially on young growth, or almost smooth on the older growth. The upper surface of the leaves is dark green and shiny; the under surface is pale and dull with prominent veins. Acorns are slim and pointed and considerably smaller than acorns of the valley oak. The bark is smooth but in old age becomes broadly ridged near the base.

The interior live oak grows in foothills and valleys away from the coast and is found along with the gray or digger pine and the deciduous blue oak. In the valleys it mingles with the valley oak, thriving best where there is a fairly constant supply of water.



WALNUT FAMILY
Juglandaceae

CALIFORNIA BLACK WALNUT *Juglans hindsii*

The black walnut ranges in size from a small shrub to a large tree, but it generally grows 30 to 60 feet high with a clear erect trunk. The compound leaves are 9 to 12 inches long with 9 to 17 light yellow-green leaflets. The male pollen-bearing flowers are long and pendant; the female flowers are small bud-like bodies which develop into round green-covered nuts. The young bark is pale but becomes dark gray and deeply furrowed and ridged as the tree grows.

Native walnuts are ancient trees but in the western United States are found only in parts of California. The oldest records available show that they originally grew on the banks of the Sacramento River in the vicinity of Walnut Grove and in the valley near Walnut Creek in Contra Costa County. Black walnuts are often associated with sites of old Indian villages and cultivation carried this tree up into the Gold Rush country. Today, squirrels spread the tree when they carry off nuts to bury. Sometimes flood waters will carry the heavy seeds to new sites.

VALLEY OAK *Quercus lobata*

The valley oak is the highest form of vegetation in this region, the climax plant. The trunk usually divides well above the ground and the tree itself may grow to over 100 feet. The limbs spread at wide angles forming a broad head of slender branches that droop in long sprays. It is deciduous, and in winter the dark lacy patterns of the bare branches stand out boldly against the sky. The leaves are usually 3 to 4 inches long and 2 to 3 inches broad, yellowish-green above, paler beneath. The leaves are parted nearly to the midrib into paired lobes, hence the name *lobata*. The acorn is long and conical with a warty cap. The bark is thick and checkered. The valley oak is found in the rich soil of the Sacramento and San Joaquin Valleys, Sierra foothills and Coast Range valleys, but not in the valleys facing the sea.

Trappers and early settlers found magnificent oaks in California's broad valleys along streams and in open stands where the roots could reach a year-round water supply. Diaries of early explorers mention the valley oak as a tree of graceful beauty. Native people depended upon acorns of the abundant oaks for a large part of their diet. Early Californians used tannin from the bark for tanning hides. Oak galls plus rusty iron were used to make ink. Gray squirrels still eat the acorns, and acorn woodpeckers store them for food and for the insect larvae they may contain.

Oaks are excellent ornamental trees. They are not as slow growing as is popularly supposed, and their permanence, stability and individuality recommend them for planting over many introduced species.

BLUE OAK *Quercus douglasii*

This deciduous oak has dense foliage similar to the live oak. It has a rounded crown and grows 20 to 70 feet high. The leaves are bluish-green above, pale beneath. They vary in size and shape; some are coarsely and unevenly toothed, others are smooth. The bark is pale and covered with small scales.

The blue oak is a strikingly prominent feature of hilly parts of northern and central California. The old Gold Rush country of the Mother Lode has an abundance of this rugged tree. It grows as a smaller tree in arid regions. Where it has access to a good water supply, it attains the height and width of valley oaks.

California scrub jays find this oak as attractive as other members of its family. They gather the acorns, hiding some in the ground. The acorns they forget to dig up again may become treasured shade trees.

WILLOW FAMILY
Salicaceae

FREMONT COTTONWOOD *Populus fremontii*

This distinctive tree commonly grows from 40 to 90 feet high and has a massive crown. The trunks of very old trees will grow up to 5 feet in diameter with whitish thick bark, roughly cracked. The leaves are bright green and triangular or roundish in outline, sometimes appearing heart-shaped. The leaf stalks are flattened in a way that keeps the foliage fluttering in every light breeze. The flowers form dangling soft cottony masses which shed freely when the seeds have ripened. Cottonwoods grow in the Sierra Nevada foothills and along streams in the valleys. Hybrids occur between this native and introduced poplars.

Cottonwoods are mentioned more often than any other vegetation in the accounts of early exploration. They were a sign of water in arid lands, and the sweet inner bark was food for horses. On January 6, 1844, John C. Fremont wrote: "Taking Kit Carson with me, I made a thorough exploration of the neighboring valleys and found in a ravine in the bordering mountains a good camping place where there was water in springs and a sufficient quantity of grass for a night. Over-shadowing the springs were some trees of the sweet cottonwood which after a long interval of absence, we saw again with pleasure, regarding them as harbingers of better country." Botanists named this tree after Fremont.

WILLOW *Salix sp.*

Munz lists 31 species and 15 varieties of salix, of which seven species and five varieties occur in the Central Valley grasslands and in the foothill woods. Specific identification is often difficult but willows are generally easy to recognize by their slender pointed leaves and their vigorous growth habits. Willows are usually erect shrubs or small trees from 6 to 25 feet high, with slender gray stems, often red towards the ends. Leaves taper on both ends and grow from 1 to 3 inches long. Catkins or pussy willows appear in the spring before the leaves begin to grow. Male and female flowers appear on different plants. Pussy willows are one of the first signs of spring and a great delight to children. Willows are found along streams and thrive where there is a good water supply.

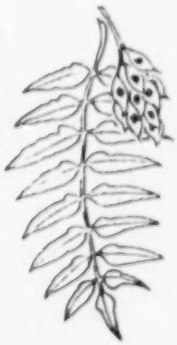
Native people made use of the pliable willow for dwellings and baskets. Furniture and baskets are still made today from branches and twigs. Willow bark, buds and wood are eaten by beaver and hare. Small mammals enjoy the foliage and catkins. Deer browse on the twigs and foliage. If you try a taste you will quickly learn to identify the bitter flavored bark.

QUASSIA FAMILY
Simarubaceae

TREE OF HEAVEN *Ailanthus altissima*

This tree grows 20 to 60 feet high. The long compound, red-tipped leaves spread out umbrella fashion. Although the flowers are green and inconspicuous, the twisted seed pods hang in showy dark red panicles. The distinctive smell of the bark and foliage, though disagreeable, helps in identification. The ailanthus or tree of heaven thrives in very inhospitable places and is resistant to dust and smoke. In some places it is a tree weed and suckers 10 feet tall will shoot up in a single season. The trees are short-lived but the wood is as strong and as useful as the wood of the ash.

This tree is an immigrant from China. A Long Island nurseryman introduced it in 1820, and the Gold Rush brought it to the Mother Lode country. Wherever the Chinese immigrants camped in the early days they planted the ailanthus, not only in the Mother Lode country but also in Australia and other parts of the world.



BUCKEYE FAMILY
Hippocastanaceae

CALIFORNIA BUCKEYE *Aesculus californica*

This low, broad-headed tree, 10 to 30 feet high, is sometimes classed as a shrub. The leaf is made up of 5 to 7 leaflets in a palmate spread. Before opening, the blossoms are erect and give the appearance of candles over the crown. When in bloom, the flower spikes are like feathery plumes. The tree loses its leaves before the hot weather is over and might give the impression that it is dead. The showy pear-shaped seeds hang onto the bare branches well into the fall. Buckeyes grow on dry hills or canyon sides.

Leaves, shoots and crushed nuts were used by the Indians to trap fish. A chemical in the plant stupefied the fish so they could easily be caught by hand. The native people also cracked, boiled and leached the large nutlike seeds to remove the harmful ingredients; then used them as food in cakes, meal or soup. Firemaking drills were made from the twigs.

MAPLE FAMILY
Aceraceae

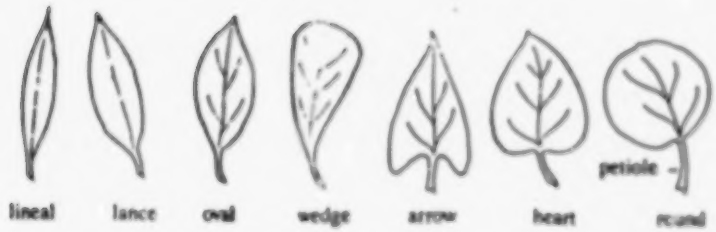
CALIFORNIA BOX ELDER
Acer negundo californicum

The California box elder may be seen along stream banks with sycamores, willows and cottonwoods. It may grow to a height of 50 feet with a short light brown trunk and a broad crown.

The compound leaves are made up of three leaflets, lobed and covered with soft down. Box elder flowers are in drooping clusters, with the male and female blossoms not only different in appearance but borne on separate trees.

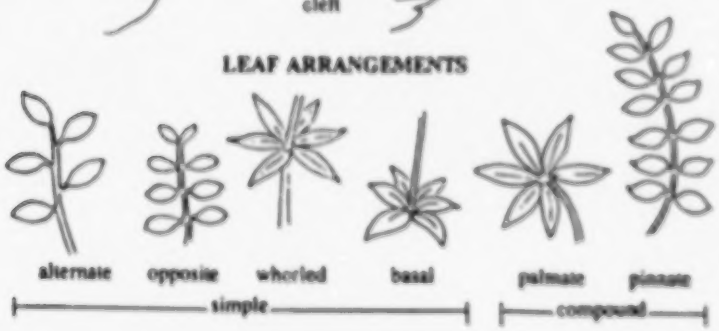
The V-shaped, winged seeds often stay on the bare tree through the winter.

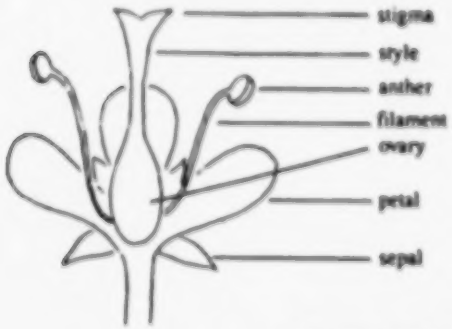
LEAF SHAPES



LEAF EDGES

LEAF ARRANGEMENTS





pistil=
stigma, style, ovary

stamen=
anther, filament

corolla=
petals taken together

calyx=
sepals taken together

FLOWER PARTS

40

A SEED IS A BEGINNING

SUMMARY OF NEXT TWO LESSONS

Students predict whether alfalfa seeds will grow in 10 different conditions created for class demonstration experiments. They also will grow their own seeds and decide where to hang them. After observing and drawing their seeds every day for a week, students make a flip book from their drawings to "see" the seed grow into a plant.

Through observing and comparing the results of these experiments, students will discover and identify different basic plant needs and conditions that affect plant growth. They also will identify any additional questions they have about plants.

Time: 50 minutes
Setting: Classroom
Materials:

For Introduction (choose one)

- Either poster of a redwood tree or other large tree
- And cone or cones from the tree in poster
- Or selection of potted plants
- Or seed packets with pictures of mature plants

For Teacher Demonstration Experiment for Class:

- The chart (described in **Preparation**)
- Small bag of potting soil
- A trowel or big spoon
- Three margarine tub-sized containers, one for each of the following water mixtures:
  1) 2 tablespoons of salt mixed in water
  2) biodegradable soap mixed in water
  3) scouring powder mixed in water
- A pitcher of water
- 10 (2" x 3") pieces of paper towel
- 10 ziplock bags
- A small bowl of alfalfa seeds (health food store)
- Scotch tape

For Hands-On Activity:

Decide the size of your groups.
Each group will need:

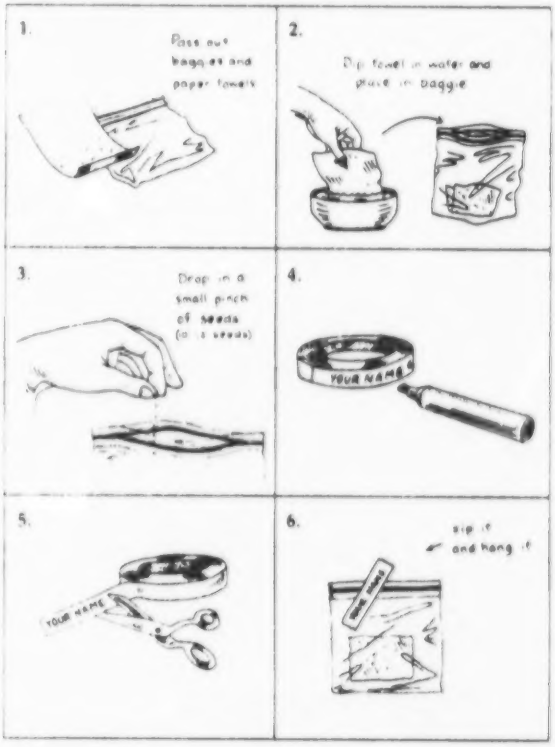
- Dish pan or tray to hold materials
- Roll of masking tape
- Ballpoint pen or marker
- One pair of scissors
- A few hand lenses (optional)
- Margarine tub or small container filled with water to dip paper towel pieces
- Sponge or paper towels for spills
- Small container of alfalfa seeds
- *Copycat Page: Directions* (optional)

Each child in the group will need:

- Cut-up paper towel about 2" x 3" (Prepare pieces in advance.)
- Plastic ziplock sandwich bag
- Pencil
- *Copycat Page: Flip Book* (duplicated on white construction paper)

PREPARATION

Draw the following diagram on the blackboard or copy it for each group of students from the *Copycat Page: Directions*.



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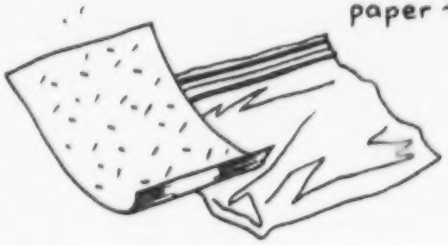
1.

Pass out baggies and paper towels

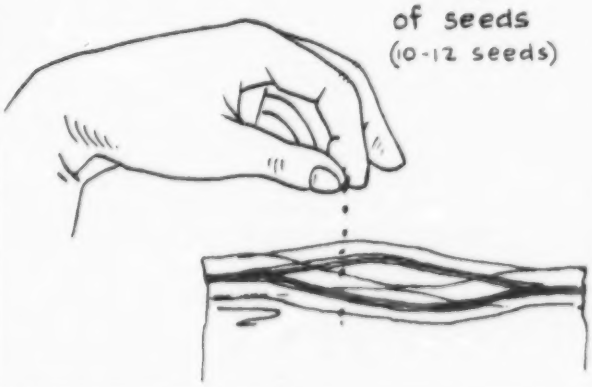


2.

Dip towel in water and place in baggie

3.

Drop in a small pinch of seeds (10-12 seeds)



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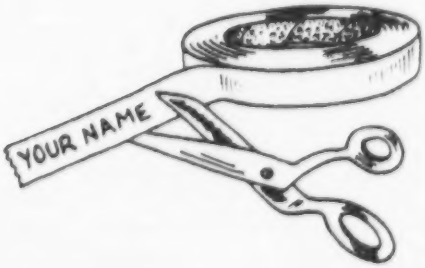
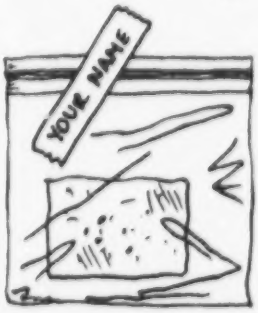
5.



6.

zip it and hang it



Tape nine plastic bags to an 18" x 24" piece of construction paper and label as shown in the diagram above. Place the paper on an easel or tape it to the blackboard. Keep demonstration supplies close by.

PROCEDURE

Day One

Introduction

1. Begin by showing the students a picture of a redwood. Explain how it is impossible to see the top of the tree because of its enormous size. Hold a tiny redwood cone in your hand and explain that the seeds for the redwood are very small and are contained within the cone.

Seeds are amazing because they contain all the food they need to start a plant or tree growing and sustain it until it is capable of producing its own food. Show different potted plants explaining that each has its own seeds. You also can pass around seed packets with photos and illustrations of the plants on the package that show what type of plant the seeds will become.

2. Explain to the students that they will practice using the same processes that scientists use: observing, guessing and experimenting to discover what seeds need and do not need to grow into plants. The first experiments will be done for the whole class; the students will then do their own experiments.

As the teacher undertakes each experiment, the students will guess or predict whether the seeds will grow. The teacher will record the students' predictions. Observation of the seeds will take place throughout the week to determine how the seeds have grown.

Teacher Demonstration

(Instructions for each experiment are contained in the following teacher narrative. Each number identifies a new experiment.)

1. "I am putting a piece of paper towel and a pinch of alfalfa seeds into the first bag and nothing else. Raise your hand if you think the seeds will grow. **(Count and record the numbers on the chart.)** How many think the seeds will grow? Does anyone think otherwise? Why?"

2. "In the second bag, I will put the towel, seeds, and lots and lots of water." **(Complete this process and record the students' predictions.)**

3. "The third bag will contain a towel soaked in salt water and seeds. What do you predict?" **(Record.)**

4. "The fourth bag will have one kind of soapy water—scouring powder." **(Record.)**

5. "The fifth will have a biodegradable soapy water." **(Record.)**

6. "The sixth will have dirt and no water." **(Record.)**

7. "The seventh will have dirt and some water." **(Record.)**

8. "The eighth, not yet taped to the paper, will have a towel dipped in water and seeds but will be twisted up into a tight little wad allowing no air or space." **(Tape up the twisted bag and record the students' predictions.)**

9. "The ninth bag will have seeds and a towel dipped in water. We will put this bag in the refrigerator." **(Record again.)**

Continued on page 9

COPYCAT PAGE: FLIP BOOK

CUT ON DOTTED LINES

FOLD ON SOLID LINES

Day

Day

Day

Day

Day

Day

Day

Plants Change

by _____

44

Student Experiment

10. Tell the students they will conduct the last experiment. This includes dipping a paper towel in water, adding seeds, putting the towel and seeds in a plastic bag and selecting a spot in the classroom to hang the experiment.

Students will draw the seed each day and record any changes on a special paper (data sheet) that will become their own flip book. Tell them to write their predictions on the back of the paper. Younger children can write "yes" or "no" as to whether they think their seeds will grow.

11. Give the students the *Copycat Page: Flip Book* data sheet and have them write their names on it. Distribute a couple of seeds to each student and 2-3 hand lenses (optional) for each group of students. Ask them to take turns looking at their seeds through the hand lens.

The students should look carefully to be able to draw the right shape. It may be a new experience to draw what they see. Explain that scientists draw what they see too.

12. Ask the students to draw the seed on the *Copycat Page: Flip Book* data sheet. Tell them they will draw the seed each day for a week. Ask them to draw it on the dot provided on the data sheet and to make it larger than the dot. Demonstrate how to do it. Have the students write the number of the day (Day 1, Day 2, etc.) on their drawing for each day they record the seed's growth. **Collect the students' papers.** Invite the students to taste the seed if they wish.

13. Have the students "read" the directions for their "planting" on the blackboard or in a hand-out. Be sure to tell them to place the tape at an angle so the bag is hung securely. Suggest that they separate one or two of the seeds from the rest so they can observe these more easily.

14. When the seeds are all in labeled bags, allow the students to place them wherever they want in the classroom. (If no one chooses a very dark place, put your experiment in that location. **Please, no clues about light.**)

Each Day During the Week

Follow-up to Teacher Demonstration and Student Experiment

Each day at the same time, return the data sheets and hand lenses to the students. Ask them to take five minutes to draw the seeds; show the students what the class chart results are so far. They may need to add a tiny bit of water to their bags if dry. The students will have to guess what happened to their experiments over the weekend to complete their drawings. Remind them to observe very carefully as they complete their drawings.

Check the students' drawings to see whether they have drawn the roots, leaves and stem.

One Week Later

Reviewing What Happened to the Seeds and Making Flip Books

Ask the students to look at their sprout drawings on their data sheets and their experimental bag of seeds.

DISCUSSION QUESTIONS

- Which part of the plant grew first?
- Which day did the brown seed coat come off?
- Look closely at the coat. Does it still have food for the seed inside it? Why not?
- When could you see the leaves?
- Can you tell where the stem meets the root? (On some of the sprouts, the root begins where the bend is.)
- Tell me about the differences between the root and the stem.
- Does anyone's plant have little tiny root hairs growing yet?
- What surprised you? Why?

MAKING THE FLIP BOOK

Provide students with directions to make a flip book:

1. Cut the rectangles on the data sheet apart on the dotted lines.

2. Stack them in order from Day One to the last day, and put the title page on top. The rectangles can be slightly staggered with the edge of rectangle two peeking out behind the first one, and so on, for easier flipping.

3. Staple the rectangles on the solid line with three staples.

4. Flip the pages with your thumb to see your seed grow.

EXTENSION IDEAS

- Take a piece of celery and cut two inches up the stalk to make two legs. Put one leg in red-colored water (use a few drops of red food dye) and another leg in plain or other colored water. Observe the celery throughout the week. This will show how a plant consumes and transports water and possible pollutants.
- Put one piece of celery in the refrigerator and the other out to dry for several weeks. Ask the children to observe the celery and notice the differences between the two. The celery that is allowed to dry out will dehydrate. The contrast between the two plants will demonstrate how much of a plant consists of water.

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A SEED BECOMES A PLANT

SUMMARY

Part Two of *A Seed Is A Beginning*

One week later, students will examine the results of the experiments with seeds and sprouts to make conclusions about the needs of plants.

Time: 30 minutes
Setting: Classroom
Materials:
- Box of alfalfa sprouts from the grocery store
- Celery stalks
- Butcher paper and marker

PREPARATION

Post the chart with the plastic bags. Take out the bags from the dark closet and the experimental seeds, grocery store sprouts and celery from the refrigerator. Place the glass with the split stalk of celery on the table.

Ask the students to prepare last week's experimental bag of seeds (now sprouts) and the data sheets for review and observation.

Prepare and post a large piece of butcher paper as shown below.

PROCEDURE

1. Tell the students that they will look at all the sprouts to see what has happened to them in a week. Ask the students to tell you what they have discovered from the experiments, what they now know, and what they think they know about the needs of sprouts and plants so you can record it on the chart. You also will record things the students think they know, but are not sure, and what they still want to know about seeds and plants.

2. First, ask the class if anyone has seeds or sprouts that have died. Reassure the student(s) that you have more seeds for them. Ask them if they have any idea why their seeds died. Typically, some will have dried out or drowned. If this is so, have the student(s) show the others.

Ask them to tell you what to record on the butcher paper. Ask the class if anyone placed their seeds in the dark.

Compare the sprouts that spent the week in the dark with those that were located in the sun. Record the students' conclusions about how light affects the leaves and length of stems.

3. Lead the students into their responses by saying: "Seeds and plants need..." Pause to let the children tell you an answer. (For example, water.) Write their responses on the butcher paper.

Recommendation: with students who are E.S.L., L.E.P. or learning to read, write "water" and make a symbol for water that everyone agrees upon. Do the same for other chart information.

4. Ask the students to review the class experiments. Look at the bags on the chart and ask what they learned about the seeds in the bag that had no water.

Next, look at the bag that had the most water and discuss and record the results. Look at the bag that had salt water and record the students' observations on the butcher paper.

5. Look at the bags with the soapy water to see the results. (It's surprising to many that sprouts can grow in biodegradable soapy water that usually carries toxic warnings for humans.)

Ask the students whether they think it would be safe to eat sprouts from either of the soapy water bags. List any questions you or the children want to know in the appropriate column.

6. Look at the bag that has dirt and no water, and the bag that has water, but was twisted up too tightly to allow for space or air. Look at the seeds from the refrigerator. Write down the students' conclusions about why these seeds did or did not grow.

The completed list of plants' and seeds' needs should include air, sun (light), space, water, warmth and nutrients. Seeds do not need light in the beginning, but do require light as they turn to sprouts so that they can become green.

DISCUSSION QUESTIONS

- What results surprised you the most?
- Look at our list of plant needs. If you plant seeds or take care of plants, what should you remember to do?
- What questions do you have about plants or seeds? (Record questions in the correct column. Below each question leave space to record an answer.)

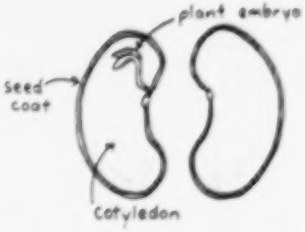
• Using the chart as a guide, help each student figure out how to find the answer to the questions. Encourage the class to research the answers and report back.

This discussion will lead to other experiments the class may wish to do. It also will help stimulate additional reading of texts or reference books. For younger children, help set up experiments and bring in books for them to read and share.

EXTENSION IDEAS

A Closer Look at Seeds and Sprouts

• Let the students each dissect a big bean that has been soaked overnight. Direct students to look for the plant embryo with its small pair of leaves and root. Ask them to find the seed coat and cotyledon where the tiny plant gets its food until it can make its own.



• Give each of the students a bunch of sprouts from the grocery store to observe. Direct students to look inside the tiny brown seed coat to see if the sprouts have used up their food. Direct the class to take a closer look at the bend of the plant where the stem meets the root. Invite students to eat the sprouts, reminding them that this was the kind of seed they grew.

A Closer Look at the Stem

(Continued from page 9)

• Show celery in two different colors to demonstrate the way a stem consumes water and (possible) pollutants. Show the celery from the refrigerator and compare it to the celery drying out to demonstrate how much of a plant is water.

SIX PLANT PARTS

Time: 50 minutes
Setting: Classroom
Materials:
• Six brown lunch bags
Put one of the following foods in each bag:

Food	Part of Plant That Food Represents
• Broccoli	flower
• Celery	stem (or petiole of leaf)
• Carrot	root
• Lettuce	leaves
• Banana	fruit
• Popcorn	seeds

1. Six groups of approximately four students are given a secret food to act out.

2. The rest of the class tries to guess what the group is. As you pass out the bags, tell the groups that they must become that object from the refrigerator together cooperatively.

3. When the students are finished, ask each group what part of a plant it played.

4. At the conclusion, the class will count how many parts of the plant were represented and name them altogether out loud.

EXTENSION IDEAS

• The Banana Slug String Band has a song called "Six Plant Parts" on a tape called *Dirt Made My Lunch*. To obtain a copy of this tape and other BSSB tapes, contact BSSB, P.O. Box 717, Pescadero, CA 94060; phone 408/429-9806. Tapes are $9.00. Songbooks are $3.00. Note: if you play this fun tape for the class, each group stands up when its plant part is mentioned.

• Have children bring vegetables and bean seeds and make a soup to share.

measure for measure

Teachers know that learning-time and play-time are one and the same. So if any part of gardening could be turned into a game, a lot of learning fun might be had by all. The vegetable gardener is asked to be a measurer in almost every garden operation — "Add 3 pounds of fertilizer per 100 square feet," "Sprinkle 2 pounds of fertilizer per 100 feet of row," "Plant 3 inches apart in rows 18-24 inches apart," "Spread 2- or 3-inch-thick mulch over 100 square feet." Certainly, in these directions there must be all the elements needed for many games of "How much?," "How wide?," "How long?"

Let's work some measurement problems by taking a youngster of 5 or 6 and playing a few games. First, let's give him a measuring stick he can be proud of — a lance to kill a dragon when he's not measuring the distance between rows of spinach. (You might as well put a metric scale on the side opposite the inch-foot-and-yard.)

With this measuring stick, he transforms himself into a live measuring machine.

A basic stick, 1⅝ x ¾ x 40 inches, with ¾ inch half-rounds attached.

Long handled tools make good measuring sticks, too.

He can become an even better measuring machine if he learns how to use his hands, fingers, feet, etc. Of course, the measurements shown on this page fit our hands, fingers, and feet. Be sure to measure your own — they might be larger or smaller than ours.

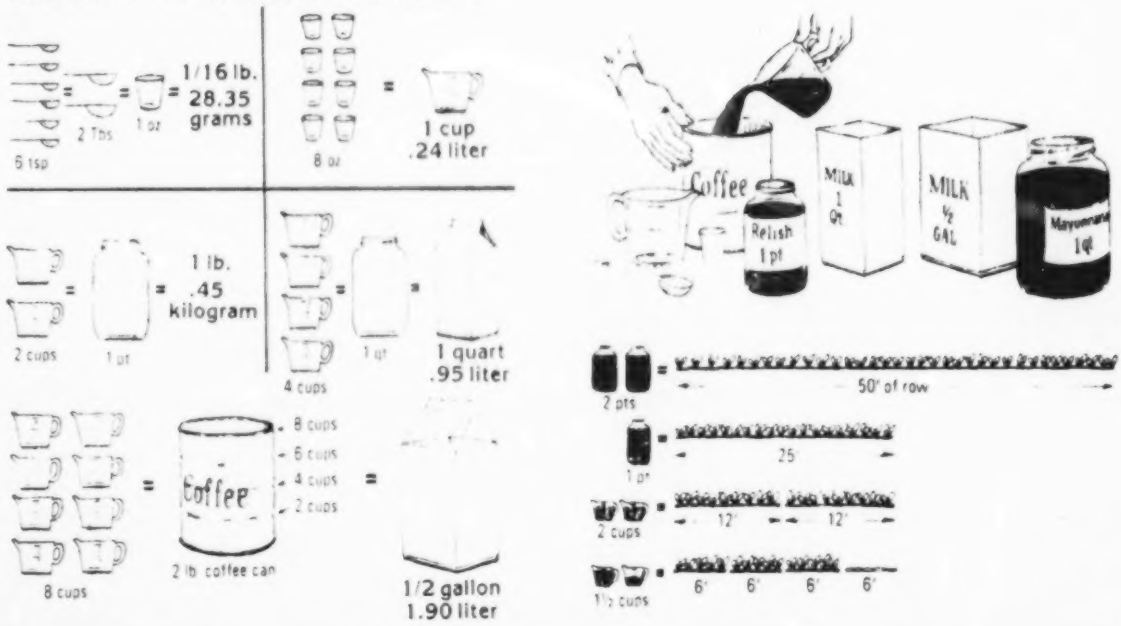
And when common household items are used in conjunction with his stick and his body our measuring machine becomes complete. Spoons, cups, jars, milk cartons, coffee cans, and soup cans are all useful in the garden — not only to measure volume, but weight as well.

If we did have a scale, we would discover that one pint of any of the dry-mixed fertilizers weighs just short of a pound. And one pint of water weighs a pound. So, with a pint of either water or dry fertilizer, we can set up our own "table of equivalents" in liquid measurements and forget the scale.

Now if you have cooked, put up fruit, or measured liquor into a glass, you can close your eyes and see an ounce, cup, pint, or quart. But our young measuring machine hasn't handled things called pints, quarts, or jiggers. A pint isn't a pint in our game until the child has poured 3 teaspoons of water into a tablespoon, two tablespoons into an ounce glass, 8 ounces into a cup, and two cups into a pint jar.

So we gather together and place before our young gardener pint and quart jars, coffee cans, 2 or 3 sizes of milk cartons, measuring cup, jigger, measuring spoons, and a half-gallon watering can. Let him see for himself how many of what equals something else. He might just find that the table of equivalents as visualized here is pretty easy to handle after all.

LIQUID AND WEIGHT MEASURE



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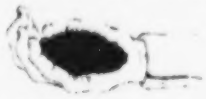
"RULE OF THUMB" MEASUREMENTS

These measurements fit our hands, fingers, and feet. Be sure to measure your own – they may be bigger or smaller than ours.

Weight of fertilizer

Postage scale

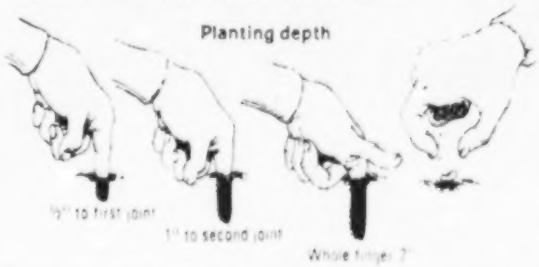
How much does your fist hold?



How much fits in your cupped hand?

When the instructions say "1 lb. per 50 ft. of row," and your hand holds 3 ounces, how many feet of row should your handful cover?

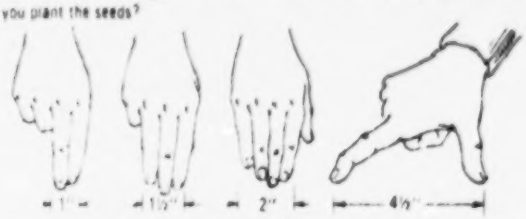
Planting depth



How long is your finger? – to the first joint? – second joint? – whole thing? How deep do you want the seeds?

Distance between seedlings

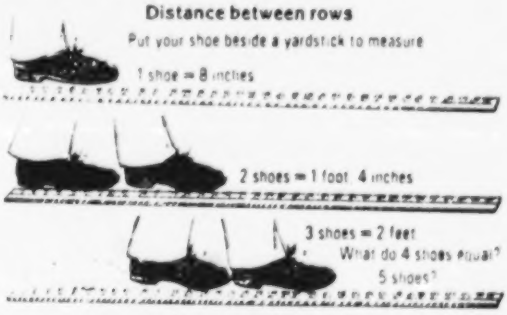
How wide are your fingers? – all four? – three? – two? How far apart should you plant the seeds?



How far can your fingers reach? – thumb to index finger? – thumb to little finger? What's the distance between seedlings?

Distance between rows

Put your shoe beside a yardstick to measure.



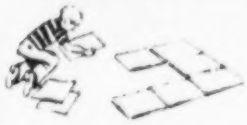
How long are your shoes? – two shoes, heel to toe? – three shoes? How far apart do you want the rows?

How long is your pace? How many paces to go 10 feet? – 15 feet? How long do you want to make this row?

SQUARE AND CUBIC FEET

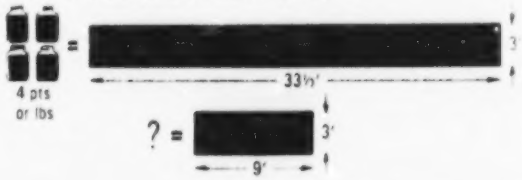
How big is your garden? 3 feet at one end, 9 feet at one side. Will some one please multiply? So it's 27 square feet.

What's a square foot?

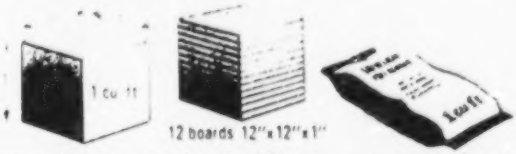


Now the counters in the game are 12"x12" floor tiles or wooden squares or any other material that can be handled.

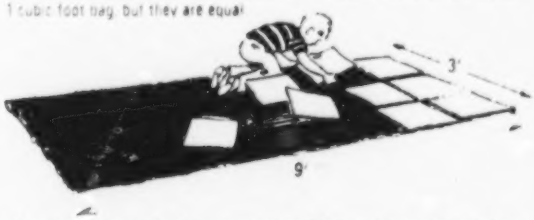
We now have a 27 square foot garden. Look what it says on the fertilizer bag. Apply 3-4 lbs. per 100 sq. ft. What part of 100 is 27? Well, ¼ of 100 is 25, and that's close enough to 27 to cheat a little and take ¼ of 4 pounds and spread 1 pound of fertilizer. 1 pint jar full.



And what's a cubic foot? Take the problem of "covering the soil with a 2 inch thick layer of peat moss or sawdust or ground bark." How much will you need? How many 1 cubic foot bags?



Have you looked at a cubic foot lately? One way to look at a cubic foot is to find 12 boards 1 inch thick and 12" on a side and stack them up. Now stand back and look. There is one cubic foot. It looks a little different than 1 cubic foot bag, but they are equal.



Now we look at our 3'x9' garden with its 27 square feet. How much will your stack of 12 boards cover? Answer: 12 square feet 1" thick.

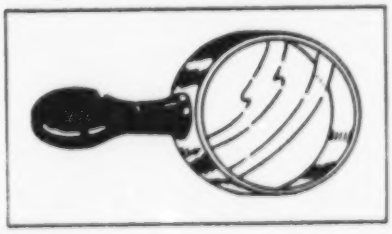
And how much 2" thick? Answer: 6 sq. ft. So, how many bags do we buy?

Answer: 5 bags will cover 30 square feet. So we buy 5 bags – that's close enough.

Fun with seeds

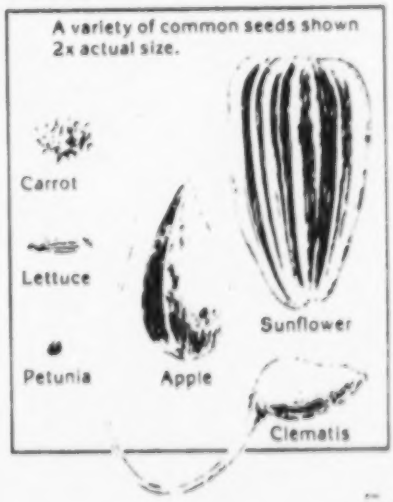
Let experimental play with seeds spark your interest in plant growth.

Before starting any experiment get together as wide a collection of seeds as you can manage. A good place to shop is a health food store. You will find the well known beans, corn, wheat, and many strange ones. These may not be the seeds to use in the germination tests but they expand the mind in the appreciation of the variety of shape and color of seeds. Add to them the left-overs from last year's seed purchases, including those that have spilled from the packets and you'll have a collection worth studying with a magnifying lens.



TEXTURES AND DESIGNS TO APPEAL

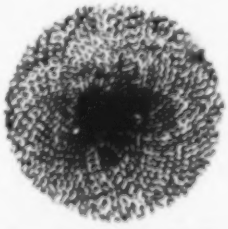
The author of the introduction to **Seeds — the Yearbook of Agriculture 1961**, Victor R. Boswell, had a good eye for seeds. "The details of the surface relief of many seeds are even more beautiful in design and precision than the mass of the seeds as a whole. Often you can find minute surface characters of surprising kinds. Surfaces that appear plain and smooth to the unaided eye may be revealed under a good hand lens to have beautiful textures.



A variety of common seeds shown 2x actual size.

"Surfaces may be grained or pebbled. They may have ridges like those of Doric columns. They may bear geometric patterns in tiny relief, forming hexagons, as in a comb of honey, or minute dimples may cover the surface. Some irregular surface patterns of surprising beauty sometimes appear under the lens. Surface may be a dull matter or highly glossy.

"Last but not least in the beauty of seeds are their surface colors. They may be snow white or jet black. The color may be a single solid one, or two or more may be scattered about at random. Colors may form a definite pattern that is distinctive and characteristic of the species and variety. The colors may be almost any hue of the rainbow — reds, pinks, yellow, greens, purples — and shades of ivory, tan, brown, steely blue, and purplish black."



Two intersecting sets of helix curves make this beautiful and efficient seed storage pattern used by sunflowers and daisies.

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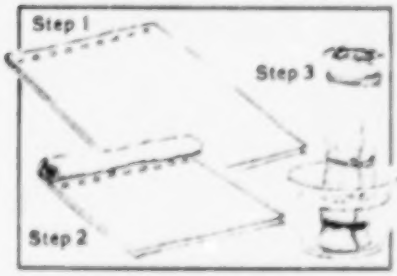
TO SPROUT OR NOT TO SPROUT

Seed Doll

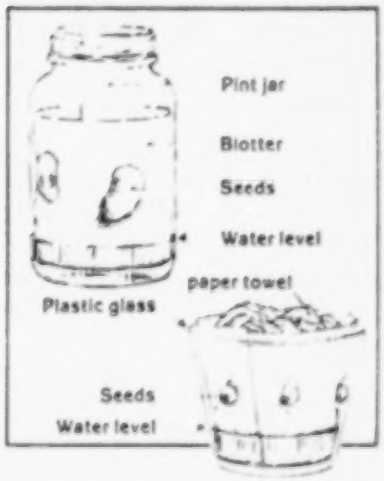
If you wish to find out if the "eating seeds" and the old seeds are viable (will they sprout?), test them in a seed doll. Take a paper towel folded double. In a row one inch from the doubled edge, place the seeds, ½ inch or more apart. When the row is set, roll the towel over the seeds. Place the second row of seeds and roll to cover. Continue until the roll is complete. Hold roll together with a rubber band. Place the roll in a glass with an inch of water. Add water when needed. Take a look in a week and see what has happened.



A MIXTURE OF METHODS

Seed view jar and seed view glass

Use a pint jar and a 4 by 8 inch blotter. Fill jar with water to saturate blotter. Pour out all but 1 inch of water. Blotter will stick to the glass. Place seeds between blotter and jar. Add water when it goes below the 1 inch level. Place the jar in a warm dark place.



You can also line a water glass or jar with 2 or 3 thicknesses of paper toweling. Put about 1 inch of water in the bottom of the glass and watch the paper soak up the water. Then place seeds between the moist paper and the glass.

To make sure that the paper towel remains firmly against the glass, stuff crumpled wet paper towels into the center of the glass.

MAY I HAVE YOUR TEMPERATURE?

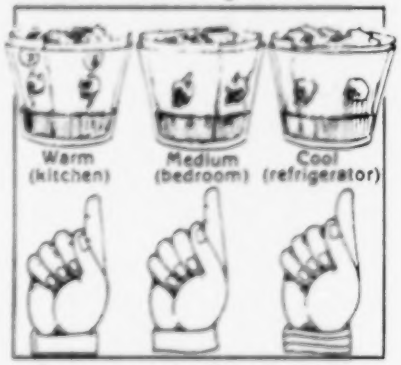
When you read the planting directions on the seed packets you will find these changes in "When to plant." "Sow seed as soon as the ground can be worked." "Plant after all danger of frost is past." "Plant seed after all danger of frost is past and the soil has become thoroughly warm."

The seeds that can be sown in cold or cool soil and grow best in cool weather are called the cool-weather crops. Those that need warm soil for germination and many days of summer heat belong to the warm-weather crop.

Tests have determined the range of temperatures at which each kind of seed will germinate. The charts tell the story.

Seed performance

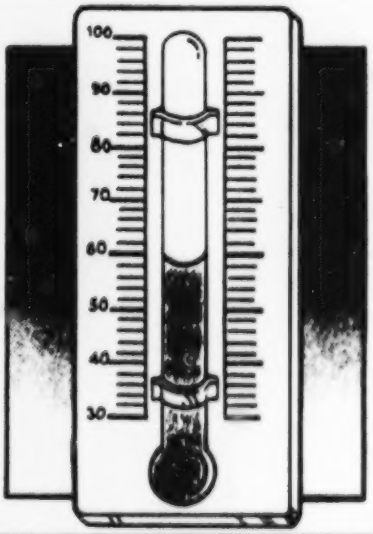
For proof of the pudding, set up this experiment. Place the same assortment of seeds in 3 glasses. Use a few beans, lettuce, and radishes . . . or snap peas, lima beans, lettuce, carrots. Get a mixture of cool-weather and warm-weather vegetables.



Place one container in the warmest spot in the house, one in a room of medium temperature and one in the refrigerator.

Check the action every day. Keep the bottom of the glass covered with water. Questions this test will answer: Do all seeds sprout at the same time? What starts to grow first, the root or the stem? Do seeds sprout sooner in a cool room or in a warm room? Do they sprout in a refrigerator?

CROP	MINIMUM TEMP. F.	OPTIMUM TEMP. F.	MAXIMUM TEMP. F.
Bean	60	80	95
Beet, cabbage, carrot, cauliflower, radish, turnip	40	85	95
Corn	50	95	105
Cucumbers, eggplant, melons, okra, pepper, pumpkins, squash	60	90	100
Lettuce, onion, parsley, peas, spinach	35	75	85
Soybeans	40	50-86	95
Tomato	50	85	95
Wheat	35	60	104



Days to appearance of seedlings at various soil temperatures from seed planted at a half inch depth*

CROP	SOIL TEMPERATURE IN DEGREES FAHRENHEIT					
	50	59	68	77	86	95
Beans, Snap	0	16	11	8	6	6
Beans, Lima	0	30	18	6	6	X
Beet	17	10	6	5	4	4
Cabbage	15	9	6	4	3	0
Carrot	17	10	7	6	6	8
Corn	22	12	7	4	4	3
Cucumber	X	13	8	4	3	3
Lettuce	7	4	3	2	2	X
Muskmelon	0	0	8	4	3	0
Pepper	X	25	12	8	8	9
Radish	11	6	4	3	3	0
Tomato	43	14	8	6	6	9

X = little or no germination 0 = not tested

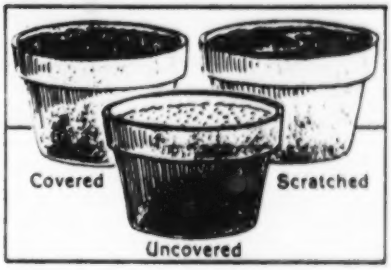
*Data compiled by Department of Vegetable Crops, University of California at Davis

Seeds planted deeper than one-half inch take more days to appear than shown in this chart. Soil temperatures are slightly cooler as you go deeper, and the seedlings have a greater distance to grow before appearing at the surface. Many seeds, when planted too early in cold soil, will rot before the temperature is right for germination.

To be sure the soil in your garden is warm enough for planting test it with a soil thermometer. By taking soil temperatures all over your garden you may find some areas warming earlier than others; these are the areas you should plant in first.

Sprouting cress

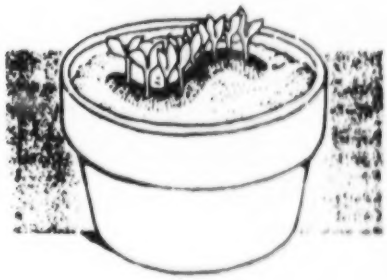
Sow seeds on the surface of moist soil in three flower pots. Quickly cover the seeds in two of the pots with ¼ inch of moist soil. Do not cover the seeds in the other pot. To prevent soil from drying out, cover all three pots with a plastic film.



In a few days seedling will appear in the pot with the uncovered seeds. No seedling will appear in the pot with the covered seeds. However if you draw a stick through the soil covering the seeds, seedlings will appear in a few days where you have scratched the soil.

Plant your name

The cress experiment outlined above suggests the possibility of sowing cress in pots or wider containers, such as flats, and "writing" on the soil. Seeds will sprout wherever the pencil exposes them to light.



Light

In the cress experiment we demonstrated that some vegetable seeds germinate better with some light. The same experiment could be made with lettuce and other vegetables. The seed packet gives directions on the depth to plant seeds for outdoor planting where the surface of the soil dries quickly. Soil in a container in a plastic bag remains moist longer. The plastic film allows air to enter but traps the moisture. The need for water is far less frequent.

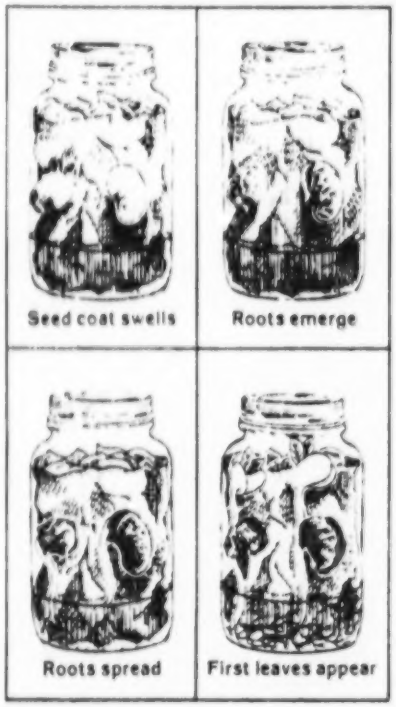
To see how the light affects the sprouting of seed, scatter a mixture of seeds over the top of the soil in one pot and press the seeds into the surface of the soil by lightly patting or with a block of wood.

In another pot scatter the same mixture of seeds. Firm them into the soil and then cover them with a thin layer of damp peat moss to exclude light.

Note that few vegetable seeds need light for germination while a number of flower seeds germinate much faster when given light. Examples: impatiens, ageratum, arabis, English daisy, Brow allia, fibrous begonia. Give them very light covering or none at all.

Quick performer

One of the most dramatic performances in seed sprouting is that of the large lima bean. Burpee's catalog gives one way of showing it: "Fill a jam or pickle jar with cotton, wool or paper tissues and place Burpee's Fordhook Lima Beans around the sides. Any bean is good to use, but we recommend limas because they're extra large. Keep the tissues moist and place the jar in a warm, dark part of the house. Within a few days you will see the seed coat swell, then split as the root system starts to emerge. Soon the roots will fill the jar and the first leaves will appear. Have your child sketch the bean's progress and he may learn a new love and respect for nature."



How deep to plant seeds?

As seen in the light experiment, some seeds require light for germination. However, most seeds will sprout in the dark. All they need is moisture, the right temperature and oxygen.

The amount of oxygen in the soil depends upon the structure of the soil and the amount of water in the soil. When water moves through the soil it drives air out by filling the air spaces between soil particles. As water drains through, air carrying oxygen moves from the soil surface into the soil.

Does the amount of oxygen in the soil vary according to the depth of the soil? Does the amount of oxygen affect seed germination? To find out, do this:

Fill a large glass with about one inch of soil. Firm the soil down and then put a few seeds next to the glass on the inside. Use large seeds such as garden beans or peas to work with. Then put one more inch of soil in the glass and firm it down. Plant a few more seeds next to the glass. Then moisten the soil with water but don't add too much. Pour off any extra water. Place in the glass in a dark place. A warm location would be best.

After a few days, check to see which layer of seeds sprouted best. Be sure that you keep the soil moist during your experiment but not too wet. If you keep the soil in the glass too wet, the seeds may not germinate at all. Seeds usually germinate poorly and most plants grow poorly in wet soils. This is due mainly to the lack of air and especially oxygen in the soil.

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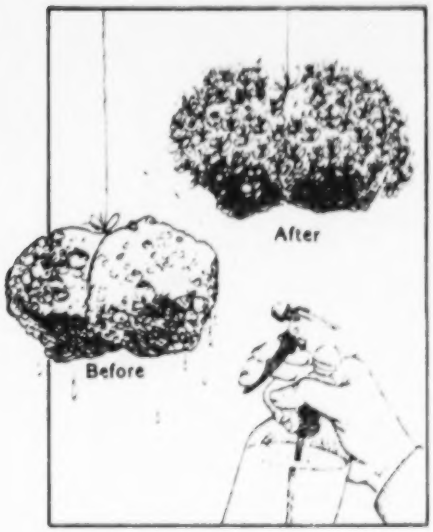
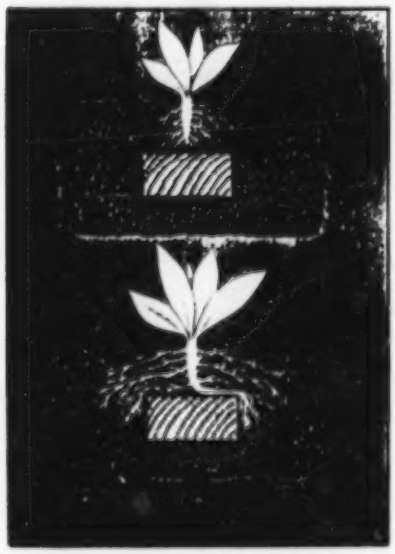
A growing sponge

Wet a big sponge and squeeze out most of the moisture. Sprinkle it with annual rye, clover, cress or mustard seeds. Tie a string to the sponge and hang it in a sunny window. If you keep the sponge moist, the seeds will sprout and cover the sponge with green.



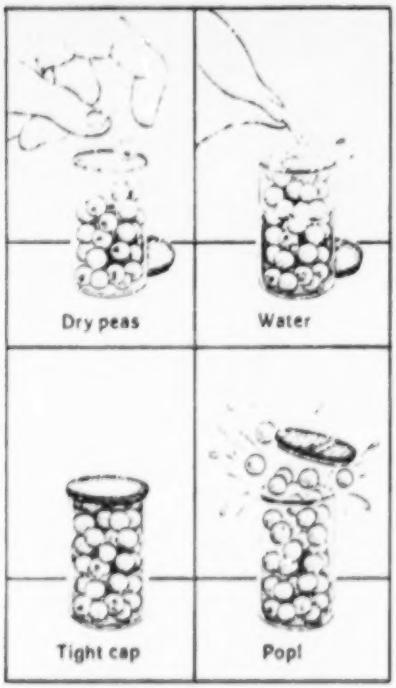
Roots make their way

Plant a seedling such as a young marigold in a flowerpot about half an inch above a piece of wood about four inches long and an inch across. Place the wood firmly so it will make a barrier as the roots go down. After a few days brush aside enough soil so you can see the roots beginning to find their way around the wood. Replace the soil, pressing it gently. Check in a few more days to see if the roots have turned completely.



Germinating seeds are strong

Fill a small bottle or plastic vial with seed (peas or beans). Fill the bottle with water. Stopper the bottle with a cork or piece of plastic held tight by a rubber band. Wait about 6 to 8 hours for the swelling seeds to pop off the cork or lift up the plastic cover. Water moves into the seed cells through the seed walls. This swells the seed and puts pressure on the container. This principle was used to stretch a tight pair of leather shoes years ago



Treasure hunt

Hide 15 or 20 objects related to gardening around the school room or home. Give each member a list of the hidden items with a blank space opposite to write in the location. At a signal the students begin looking for the hidden objects. When one is seen, the place where it is hidden is written in the blank. The item is not removed from its hiding place. The winner is the one with the most correctly located items. Examples of items to hide are a plant, kernels of corn, a trowel, an empty clay pot, large seeds such as beans, nasturtium, or sunflower.

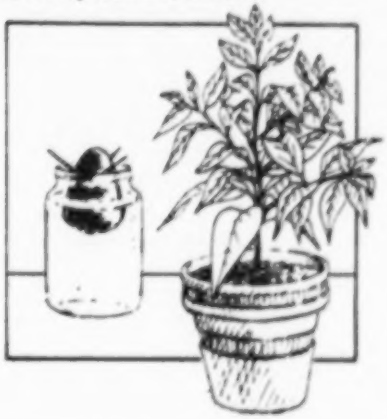
Patriotic celery

Use stalks of celery with leaves turning yellow. Place one in clear water, one in red ink or food color solution, and one in blue; leaves in bright sunshine for a few hours. You should note some change in the leaves. A cut across a piece of celery left in solution should reveal that celery "strings" are really conducting tissue. Repeat your first experiment but use one stalk of celery split three ways and straddling all three solutions. What do you see?

FROM GENERATION TO GENERATION

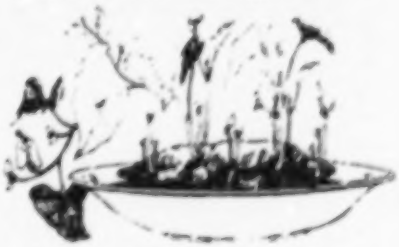
The carrot, the avocado seed, sweet potato and pineapple have given their magic to the windowsill for children of all ages for hundreds of years.

Avocado. Suspend an avocado seed in a jar of water with toothpicks. A couple of months after it sprouts you can transplant it to a pot. In a year or so it may look like this one.



Carrot hanging basket. Take a large carrot and cut it 2 inches from the top. Carve the center out. Bore holes in carrot if it is to be hung by cords. Or leave it as is, if a macrame holder is fashioned. Fill the carved-out hole with a planter mix. Sow seed of cress, mustard, morning glory, or thunbergia. Keep the soil moist. If the carrot is not extra large, keep cavity filled with water rather than soil to prevent shriveling.

Sweet potato. Suspend a sweet potato in a shallow dish of water — it will root and become a quite spectacular, though temporary, houseplant. The shoots formed for decorative purposes can be used to start plants for the vegetable garden. Pinch off the shoots and plant them in peat pots. When they are 6-8 inches tall they are ready to be set out in the garden.



Carrot and pineapple tops. An inch or two from the top of a carrot or pineapple will spring to life and leaf out as if by magic when set in a shallow dish of water and placed in a sunny window. Try it with beet and turnip tops. Will they grow too? What other vegetables can you make grow this way?

In a seed catalog dated 1877 we found this version of indoor carrot growing.

Other seeds from the grocery store: Many of the fruits and nuts you buy have seeds that you can raise into seedlings. If you have a squirrel around you know that nature has little trouble bringing along young walnut or oak trees.

Before sprouting, seeds of deciduous fruits and nuts need a period of moist winter chilling. This breaks their natural dormancy. You can supply the chill by storing them in the refrigerator at 40°. Provide moisture by placing them in plastic bags with wet vermiculite. Length of chilling time needed:

Almonds: 4 weeks
Apple: 2 to 3 months
Apricot: 3 to 4 weeks
Grape: 3 months
Peach: 3 months
Pear: 2 to 3 months
Walnuts: 3 months
Grapefruit: no chilling required — plant anytime

Plant walnuts 4 to 6 inches deep, the others about 3 inches deep.

Fruits and nuts you grow from store-bought produce are plants mainly to play around with. They can't be counted on to grow into productive trees. Orchard trees are not grown from seeds, but from carefully selected grafts and buds on seedling rootstocks.

Storage roots. The roots of some plants are modified to store food for later use by the plant. The following paragraphs are from **Introductory Botany**, by Arthur Cronquist, published by Harper & Brothers: "Most roots store some food as well as serving in anchorage and absorption. Carbohydrates, especially starch and sucrose, are the foods usually stored. Sugar beets commonly contain 15-20 per cent sucrose.

One of the commonest types of modified root is the fleshy storage root. Many biennials produce a fleshy storage taproot during the first year and use up the stored food the following year when flowers and seeds are formed. Carrots, beets, parsnips, turnips, and radishes are familiar examples, although some of these may be induced to mature the first year."

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Water

Water, clean water, is just as important as food to living things. Animals and plants cannot go very long without water. About 85% of your body is water. Your body gives off water. When you sweat, some of the water evaporates and makes you cooler. You need more water every day so that you do not dry out. Why do you need to drink more in the summer than in the winter?

Water should never be wasted. Even though it can't be destroyed, if it isn't used wisely, there may not be enough of it in the right place at the right time.

In the picture, you can see where water is stored and the long pipes it goes through to get to the city. Rain helps fill the RESERVOIR and so do the rivers and springs.

TRY THIS!

See how much water can be wasted by just one leaky faucet. Put a container under the faucet with a slow drip, and measure the amount of water in the can after 1/2 hour.

Can you name some ways we can conserve water?

1. _____

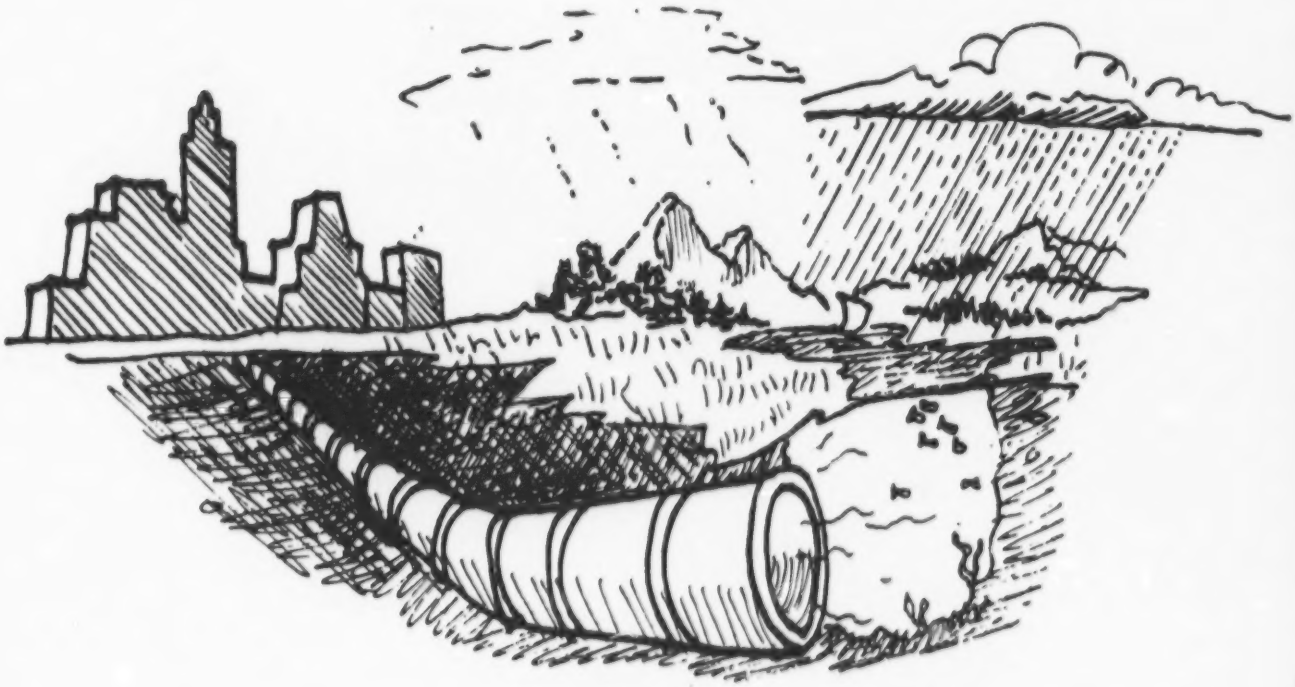
2. _____

3. _____

4. _____

WALK 9

Rain



WALK 9

What Happens When It Rains?

Walk outside after a heavy rain. Check where you find puddles. Check how big the puddles are.

	Big Puddles	Small Puddles	No Puddles
On the grass			
On a bare patch of lawn			
Under street trees			
On the sidewalk			
In the gutters near the curbs			
In the middle of the street			
Other places			

Did you see any little "rivers" running down driveways or lawns? _____yes _____no
If so, are they _____clear? _____muddy?
Collect some of the muddy water. Let it stand. What happens?
Does mud settle out? _____yes _____no
Why do you think this happens?

If there is a sloping lawn near your school, are there bare patches on it?
_____yes _____no

Are the bare patches smooth and even or uneven, like ruts? Why do you think this happens?

On a dry day, look to see if there are any pieces of soil lying in the sidewalk or in the gutter. Are all the little pieces the same size?
_____yes _____no
Do you find little pieces of the same size together or scattered?
_____together _____ scattered

Draw a picture showing how these particles are scattered.
Does this scattering tell you which way the water was flowing? How can you find out?

56

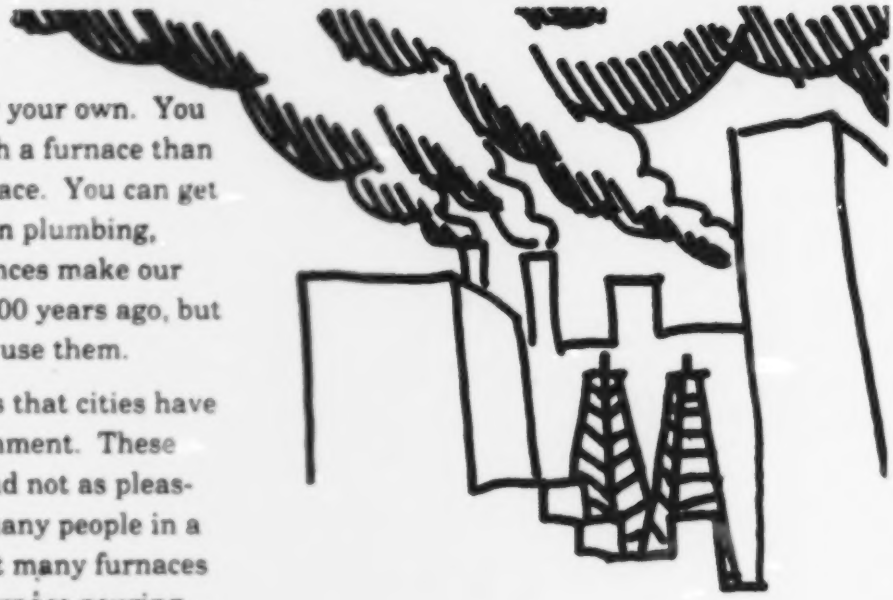
Cities Change the Environment

We said that the city might be your environment. All the buildings, cars, trucks, and other people are part of it. The air, water, other animals, sunshine, and plants are also parts of it. These last five were not made by people and are part of the NATURAL ENVIRONMENT.

Cities change the natural environment. If lots of people walk on a street everyday, there has to be a hard covering that won't wear out for a long time. That means there will be less soil for plants to grow and so, there will not be as many plants. Our oxygen will have to blow over to us from other parts of the country, where there are more plants.

Cities change the natural environment in other ways too. Tall buildings cut down on sunlight. They change the climate. Where you see a twenty-story building now, perhaps there once was a pond. Instead of a woodchuck hole under the ground, there are telephone wires and water pipes. Other animals that need large habitats have moved away because people took up more and more of the room they needed.

These are some of the changes people have made in the natural environment. The changes have made life easy for people in some ways. It is easier to buy food in



a store than to hunt or grow your own. You keep warmer in a house with a furnace than in a house with only a fireplace. You can get water from the sink. Modern plumbing, heating, cooling, and appliances make our everyday lives easier than 100 years ago, but you need to conserve as you use them.

There are other changes that cities have made on the natural environment. These changes make life harder and not as pleasant. Because there are so many people in a city, there have to be a great many furnaces to keep them warm. One furnace pouring smoke into the air isn't too bad. But when there are hundreds, it makes the air dirty. The air is less healthy and makes clothes and paint dirty too. See page 28.

TRY THIS!

Rub some Vaseline on 4 pieces of paper (or 3x5 cards). Put the cards on a window sill, at home or school. After one day take away one card and put it where it won't collect more dirt. The next day do the same thing with another card. Do this until you have taken away all the cards.

On the last day, look at all 4 cards. Compare the amount of dirt on each. Look at the dirt under a magnifying glass. Do you think the air in your city is clean or not? Why? How do you feel about your answer? Why? What can you do to keep air clean?

This dirt makes water dirty too. Most cities have to pay to buy clean water from far away.

58

Cities change the natural environment. A river running through a city can be very pretty. Do you have a river in your city? Which picture does it look like?

Describe your river. What do you think about your river? Do you like it? Why?

Getting rid of garbage is also a real problem in crowded cities. People have to get it out of their homes. Garbage must be picked up from the street. And then it has to be put some place away from people. Is your garbage taken somewhere "away" from people? How can you find out? Where does it go? Do you recycle?

Too often the waste from houses and factories is thrown into the river. This makes the water unfit to drink. The dirty water kills the fish and other animals which live in clean rivers and lakes. You cannot go swimming because the water is not clean. People might get sick from the dirty water or from eating fish from dirty water.

This kind of human-made dirt in air and water is called POLLUTION. Another kind of pollution is called LITTER. One small candy paper on the sidewalk is bad enough but when hundreds of people throw small pieces of paper on the ground it makes a big mess.

WALK 10

Some ways people are hurting the ENVIRONMENT

Noise can be another POLLUTANT. Noise doesn't do anything to air, water, food, and shelter but it does something to you.

In cities you hear noise from trucks, cars, buses, trains, air hammers, horns, garbage cans, radios, airplanes, and many other things. All this noise can make you feel angry or restless and uncomfortable. Too much noise is not good for anybody.

You have just looked at some of the parts of the environment that people have changed. Maybe we forgot to think ahead when we made some of these changes but we are part of the environment. We are as important to it as the other living things found here. We are even more important! Humans have minds that can think and plan ahead and choose what to do. Some of the human-made changes to the environment are not good. Something can be done but it will have to be done by us. You are a person. You can plan ahead. You can help change your environment. You can help make it a better place for all plants and animals.

WALK 10

What Are Some Ways People Are Hurting the Environment?

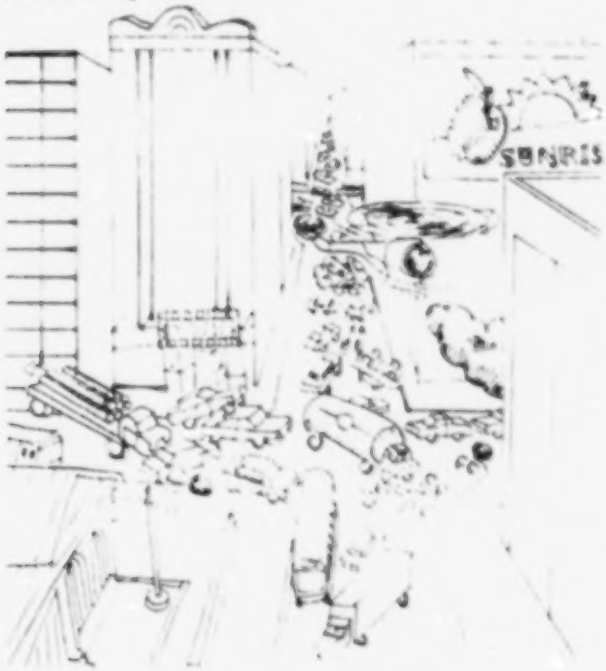
AIR POLLUTION

1. Stand outside your school. Look all around. Check all the places you can see that air pollution is coming from.

List them:_____

_____

Is this good or bad? Why? What can you do about air pollution?



2. Describe the sky.

Is it clean? _____yes _____no

Is it hazy? _____yes _____no

Is it darker in some parts than others?

_____yes _____no

3. Can you smell the air?

_____yes _____no

Does air have a SCENT? Why ?

4. Do your eyes tear or hurt?

_____yes _____no

If possible, watch a bus leave a bus stop. Can you see the EXHAUST?

_____yes _____no

Can you smell the exhaust?

_____yes _____no

What do you think about exhaust?

5. Try to collect some pollutants.

a. Wipe a car with a tissue. Paste a piece of the tissue in square a:

b. Wipe a window sill with a tissue. Paste in square b:

c. Wipe a plant with a tissue. Paste in the square c:

d. Go to a tree near a bus stop. Wipe a leaf with a tissue. Paste in the square d:

e. Go to a tree as far away as possible from bus stops and heavy traffic. Wipe a leaf with a tissue. Paste in the square e:

a.	b.
c.	d.

e.

6. Sandpaper a small section of the stones on the outside of the school building. Is there a difference in color? _____yes _____no

7. If there is snow on the ground, what color is it? _____white _____gray
Discuss why. How long ago did the snow fall?
_____today _____yesterday
_____a few days ago

LITTER

Examine the litter under a tree, on the grassy strip between the sidewalks and the street, or in a vacant lot. Check the things you find. Some of these things will come apart soon. Some will last a long time and make the ground ugly. Draw a line from each thing you found to the right group.

newspapers
cans
glass
junk furniture
foil
candy wrappers
cigarettes
styrofoam
plastic items
bottlecaps
paper cups
other_____

GROUP 1
Things that will make soil soon.

GROUP 2
Things that will not make soil soon.

GROUP 3
Things that will never make soil.

62

What do you think of these three groups? What do you suggest we should do about GROUP 3?

SCHOOL ENERGY MAP

OBJECTIVES: Students will become aware of the energy users at school.

SUMMARY: A map of the school will be made, and the energy users on campus charted and discussed.

GROUPING: 4-6 students.

TIME: 50 min.

SUBJECTS: Math, geography, social studies, science, language arts.

VOCABULARY: Scale, conserve, deferred, utility, budget.

MATERIALS:
- ❑ Energy Users Worksheet
- ❑ Tape measures
- ❑ Graph paper

PREPARATION & BACKGROUND: According to the California Energy Extension Service, typical schools spend the bulk of their energy dollars on lighting (28%), heating (25%) and cooling (13%). Other energy uses are; air handling (15%), hot water (5%), and "other" (14%). Students and staff can have a huge impact on these costs. We often use energy without realizing it. We tend to take lights and copy machines for granted. In this exercise, the students will look carefully at the energy users in their school, and learn about how the school's energy budget is spent.

You will need to find out what the utility rates are, and how much the school spends on energy. This information is all in the school utility bills; the administration should be able to provide a copy for you. Use a bill for the same month from last year. Take the total bill (gas + electrical) and the percentages given above, and determine what your school spends on energy in the different categories. (For example: Lighting % x total utility bill = approximate amount spent on lighting for one month; repeat for heating, cooling, etc.)

When students do the mapping, it is instructive to have access to water heaters, space heaters and cafeterias. You could pre-arrange with the custodian to help out, to open doors and accompany students in areas with large machinery. This activity can be expanded to the school district or contracted to individual wings or classrooms. To shorten and simplify the activity, you can make up blank school maps to be filled in. Otherwise it might be instructive to use graph paper, and discuss drawing to scale. Simple sketches of the school will do also. Choose the option best for your class, YOU are the expert in that department!

PROCEDURE:

1. Divide students into groups of 4-6. If you have ready-made maps, the smaller group is more appropriate. Tasks can be divided among the students. One student can translate input from others and draw the map, another can record energy users, while two students scan the area and report the things they find that are using energy.
2. Assign a portion of the school to each group. If each group works in the same scale an entire map of the school can be assembled.
3. Students will then tour the school with the worksheet that follows. They are to carefully make note of every energy user they can find, noting where they found each. (e.g. lights, refrigerators, heaters, copy machines, etc.)
4. When the maps are done, have students list all the energy users in their area. Encourage the students to be thorough. Rather than list "lights" have them be specific (e.g. 10 fluorescent lights, and 2 regular, incandescent lights).
5. Have the class reassemble and report on what they found.
6. Next, brainstorm with students how the school might save energy. You can list the ideas on the board as they volunteer thoughts like: close doors to keep heat in or out; turn off the lights next to the windows on bright days; weatherstrip the windows and doors; turn off lights during recess and after school; and reset thermostat to 68/80.
7. Distribute the worksheets and have students fill in what type of energy is being used and propose alternatives where possible. Doing the two previous activities will help students know how to complete the worksheet.

FOR DISCUSSION: 1. Do you think other people in the school realize how much energy they use?

2. Most homes use more energy for heating and cooling; schools typically use more for lighting. Why do you think there is a difference? (Hint: Lots of bodies in a classroom help keep the room warm.)

3. How can individual students help save energy at school? At home?

EXTENSIONS: 1. Repeat the exercise, only have students do their own homes this time.

2. Have students write an essay about what they think the money saved should be spent on.

3. Students could prepare a pamphlet on simple ways to save energy at school and distribute it to all classes.

4. Make posters on how to save energy at school and post them around campus.

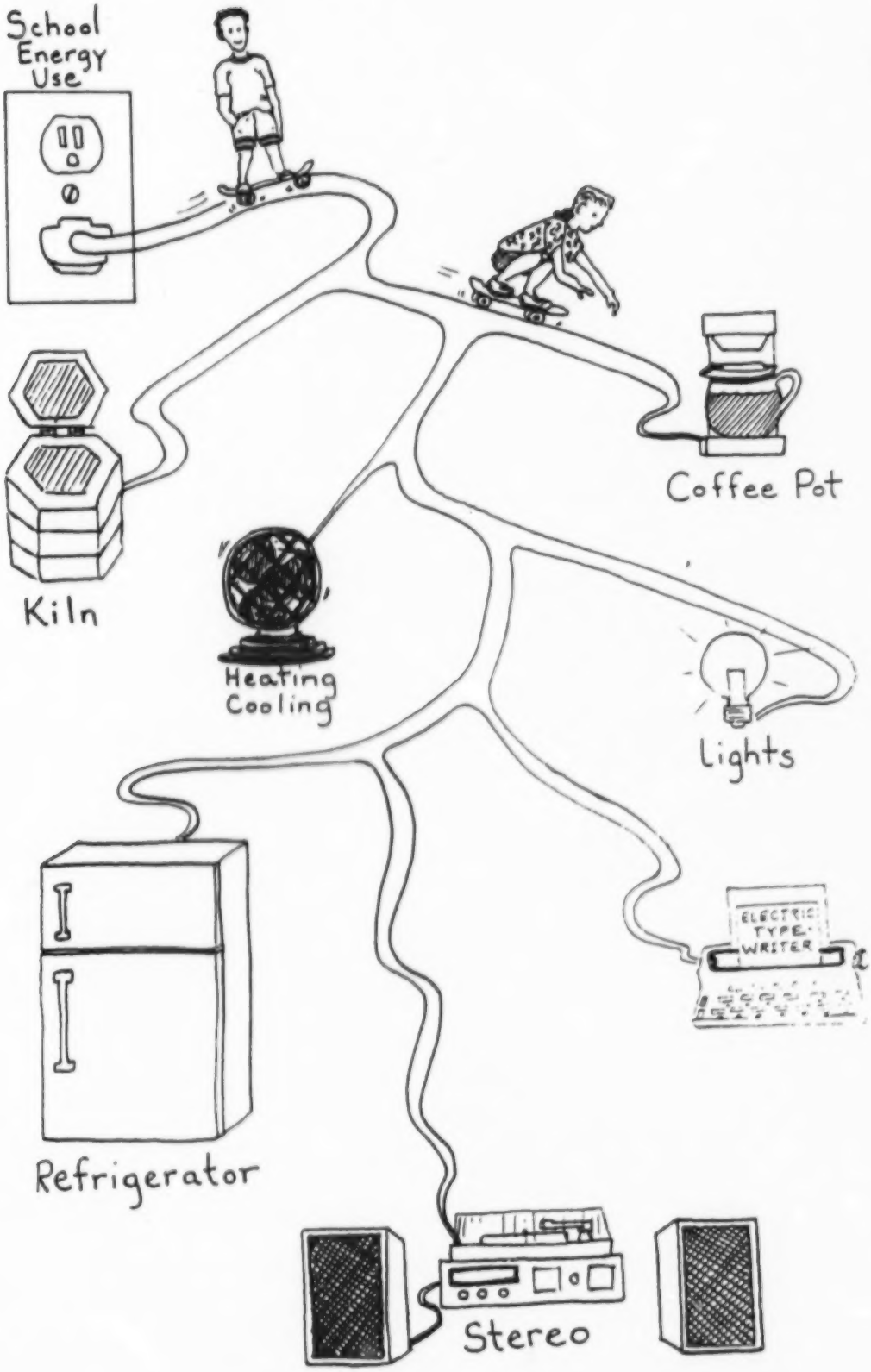
64

ENERGY USERS WORKSHEET

Names:

Area Mapped:

THINGS THAT USE ENERGY	ENERGY SOURCE	RENEWABLE? YES / NO	ALTERNATIVES OR REPLACEMENT?


School Energy Use
Kiln
Heating Cooling
Coffee Pot
Lights
ELECTRIC TYPE-WRITER
Refrigerator
Stereo

Classroom Conservation

OBJECTIVE

Students will be able to suggest ways that paper and other natural resources can be reused and recycled in the classroom.

ACTIVITY

For one week, ask your students to save all waste paper generated by class activities. Assign groups to separate the papers into two stacks each day: One for paper that has been completely used and the other for paper that could be used again for some purpose.

At the end of the week, compare the amount of paper in the stacks and lead a class discussion on "Are we wasting paper?" Give each group some of the reusable paper, pencils, and one of these articles: grocery bag, shoe box, magazine, gift-wrap paper, Christmas cards, newspaper, lunch sack, milk carton.

Ask each group to list on the paper all the ways they can think of to reuse the article. After 10 minutes, share the ideas. Repeat this exercise with articles like ditto paper and other items commonly used in the classroom, such as pencils and crayons. You and the students can act on the suggestions you consider most worthwhile, making them a part of your classroom way of life.

Suggestions for a few classroom conservation activities:

1. Maintain a room recycling center (at Christmas time you might call it Santa's Recycling Workshop). Make gifts, models, table decorations, collages, bookmarks, name tags, and anything else students can suggest out of products for recycling from school and from home.
2. Give each student a 12 by 12 inch (30 by 30 centimeter) piece of Masonite painted a slate color to use instead of paper for practicing writing and drawing skills. Use chalk and erase the markings with a damp cloth at the conclusion of each exercise.
3. Instead of using construction paper to teach color awareness, try using colors cut from magazine pictures.

SUBJECTS
Social Studies
Fine Arts

GRADES
K-6

PLT PRINCIPLES
7. Lifestyles
5. Management and Interdependence of Natural Resources
2. Diversity of Forest Roles

CONCEPTS
7.31 Consumer Effects on Forest
5.12 Renewable Resources
2.112 Forest as Resource Pool

SKILLS
V. Problem Solving
VI. Valuing

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Who Runs This Place?

SUBJECT
Social Studies

GRADES
7-12

PLT PRINCIPLE
4. Societal Perspectives on Issues

CONCEPTS
4.2 Decision-Making Process
4.22 Pressure-Group Influences
4.222 Benefits of Citizen Participation

SKILLS
III Social Participation
V. Problem Solving

OBJECTIVE

Students will be able to describe the means by which a law might be changed as a result of a change in environmental practice.

ACTIVITY

Some changes that would improve environmental quality require changes in or additions to laws. To initiate these changes, citizens must know which officials have jurisdiction over what areas and the extent of their authority. This activity explores environmentally related laws and government authority at the local level.

Ask your students to devise a question about a current environmental concern in their community. Some possibilities are:

- Why don't we have more trees?
- Why don't we have more parks or open spaces?
- Why isn't paper being recycled?
- Does our community have a land-use plan?

If the students want to identify several problems, they might divide into small groups with each group investigating one of the problems.

Next the students might go to their local government offices to find out:

1. Who is in charge (of planting more trees, establishing more parks or dealing with whatever the problem is)?
2. What statute forms the basis for this person's authority?
3. What branch of community government administers the problem area?
4. What is the source of revenue for this government department? How and when are its funds budgeted?
5. In what ways is the department attempting to solve the problem? If no attempts are being made, why not?
6. Does a proposed solution to the problem require a change in a law or other regulation? If so, would the change be in municipal or county codes, standards, zoning regulations, or what?
7. How is the law or regulation changed?

After students have completed their investigations, the class as a whole can select a single problem from among those studied and attempt to solve it.

ARBOR DAY POEMS

TREES

I think that I shall never see
A poem lovely as a tree

A tree whose hungry mouth is pressed
Against the earth's sweet flowing breast;

A tree that looks at God all day
And lifts her leafy arms to pray;

A tree that may in summer wear
A nest of robins in her hair;

Upon whose bosom snow has lain;
Who intimately lives with rain.

Poems are made by fools like me,
But only God can make a tree.

--Joyce Kilmer

What does he plant who plants a tree
He plants, in sap and leaf and wood,
In love of home and loyalty,
And far-cast thought of civic good
His blessing on the neighborhood.

--Charles Lathrop Pack

THE TREE PLANTER

Whoever planted rows of trees
Beside the roads and lanes,
God rest his soul in Heavenly peace
And bless him for his pains:
For he who gave of time and toil,
Who gave of heart and hand
To nurse the tender shoots that were
To shade the ways of man,
Was quite as great as those who built
Of stone and minted gold--
No need to cast his name in bronze,
His deeds need not be told.

--Stanley Foss Bartlett

PLANTING A TREE

What does he plant who plants a tree?
A scion full of potency;
He plants his faith, a prophecy
Of bloom, and fruitfulness to be;
He plants a shade where robins sing,
Where orioles their nestlings swing:
A Burning Bush, -- a miracle!
Who plants a tree, -- he doeth well!

What does he plant who plants a tree?
He makes a strong mast for the Sea;
He makes the earth productive, fair;
He helps the vines climb high in air,
And from their censers shed perfume
To sweeten Night, and bless high Noon.
Against the vandals who despoil
He sets his protect in the soil.

What does he plant who plants a tree?
An emblem of the Men to be:
Who lightly touch terrestrial clay,
But far above the earth, away
From sordid things and base,
Incarnate ideals for their race, --
Who plants a tree, he doeth well, --
Performs with God, a miracle!

--Author Unknown

ARBOR DAY

"Tree Planting Day" they called it
In Nebraska long ago.
Now we call it Arbor Day, and
Oh, I love it so!
I love to plant a growing thing --
A tree, a shrub, a vine --
And know it will for years and years
Keep growing there, a sign
To children who come after me
That someone thought of them,
And left behind a living friend
More precious than a gem.

--Betty Foust Smith

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WHAT DO WE PLANT WHEN WE PLANT THE TREE?

What do we plant when we plant the tree?
We plant the ship which will cross the sea,
We plant the mast to carry the sails,
We plant the planks to withstand the gales--
The keel, the keelson, the beam and knee--
We plant the ship when we plant the tree.

What do we plant when we plant the tree?
We plant the houses for you and me.
We plant the rafters, the shingles, the floors,
We plant the studding, the lath, the doors,
The beams and siding, all parts that be,
We plant the house when we plant the tree.

What do we plant when we plant the tree?
A thousand things that we daily see.
We plant the spire that out-towers the crag,
We plant the staff for our country's flag,
We plant the shade from the hot sun free:
We plant all these when we plant the tree.

--Henry Abbey

AN ARBOR DAY TREE

(For four small children)

All: "Dear little tree that we plant today, what will you be when we're old and gray?"

First: "The savings bank of the squirrel and mouse, For the robin and wren an apartment house."

Second: "The dressing room of the butterfly's ball, The locust's and katydid's concert hall."

Third: "The school boy's ladder in pleasant June, The school girl's tent in the July noon."

Fourth: "And my leaves shall whisper right merrily. A tale of children who planted me."

--Author Unknown

TREES OF THE FRAGRANT FOREST

(For six children. As they take their places upon the stage, those in seats recite the first stanza.)

Trees of the fragrant forest,
With leaves of green unfurled,
Through summer's heat, through winter's cold
What do you do for our world?

First: Our green leaves catch the raindrops
That fall with soothing sound,
Then drop them slowly, slowly down;
'Tis better for the ground.

Second: When, rushing down the hillside,
A mighty freshet foams,
Our giant trunks and spreading roots
Defend your happy homes.

Third: From burning heat in summer
We offer cool retreat,
Protect the land in winter's storm
From cold, and wind, and sleet.

Fourth: Our falling leaves in autumn,
By breezes turned and tossed,
Will rake a deep sponge-carpet warm,
Which saves the ground from frost.

Fifth: We give you pulp for paper,
Our fuel gives you heat;
We furnish lumber for your homes,
And nuts and fruit to eat.

Sixth: With strong and graceful outline,
With branches green and bare,
We fill the land through all the year,
With beauty everywhere.

All: So listen! From the forest
Each one a message sends
To children on this Arbor Day:
"We trees are your best friends!"

--Primary Education

70

FOREST PLANTING

What do we plant when we plant a tree?
A thousand blessings for you and me--
We plant the lumber to build us a house,
We plant a cover to harbor the grouse;
We plant the fuel to kindle our fire,
When strikes the prices of coal send higher;
We plant for fences the posts and rails,
We plant a shelter to temper the gales.

We plant the pencils to scribble our notes,
We plant the ballots to cast our votes;
We plant the paper in which to read,
The news that o'er wooden poles we speed,
We plant the piles to erect our docks,
We plant the rayon for shirts and socks;
We plant the extract to tan our shoes,
We plant (most anything you choose!)

We plant the barrel, the box, the crate,
In which to ship all sorts of freight;
We plant the cars to carry the grain
The farmers raise on the Western plain;
We plant the sleepers under the track
O'er which we send our products back;
We plant a blanket to hold the soil,
We plant good wages for those who toil.

We plant a forest sponge to check
The menace of the wild flood's wreck;
We plant refreshment, rest, and health,
We add our share to the Nation's wealth.
We plant a stately cathedral where
To worship God in the open air;
Beauty, contentment, prosperity,
All these we plant, when we plant a tree.

--Samuel T. Dana

I LOVE A TREE

When I pass to my reward,
Whatever that may be,
I'd like my friends to think of me
As one who loved a tree.

I may not have a statesman's poise,
Nor thrill a throng with speech,
But I may benefit mankind
If I set out a beech.

If I transplant a sapling oak
To rear it's mighty head
T'will shade and shelter those who come
Long after I am dead.

If in the park I plant an elm
Where children come to play
T'will make for them a childhood shrine,
That will not soon decay.

Or if I plant a tree with fruit,
On which the birds may feed,
Then I have fostered feathered friends
And that's a worthy deed.

For winter when the days grow short
And spirits may run low
I'd plant a pine upon the scape
T'would lend a cherry glow.

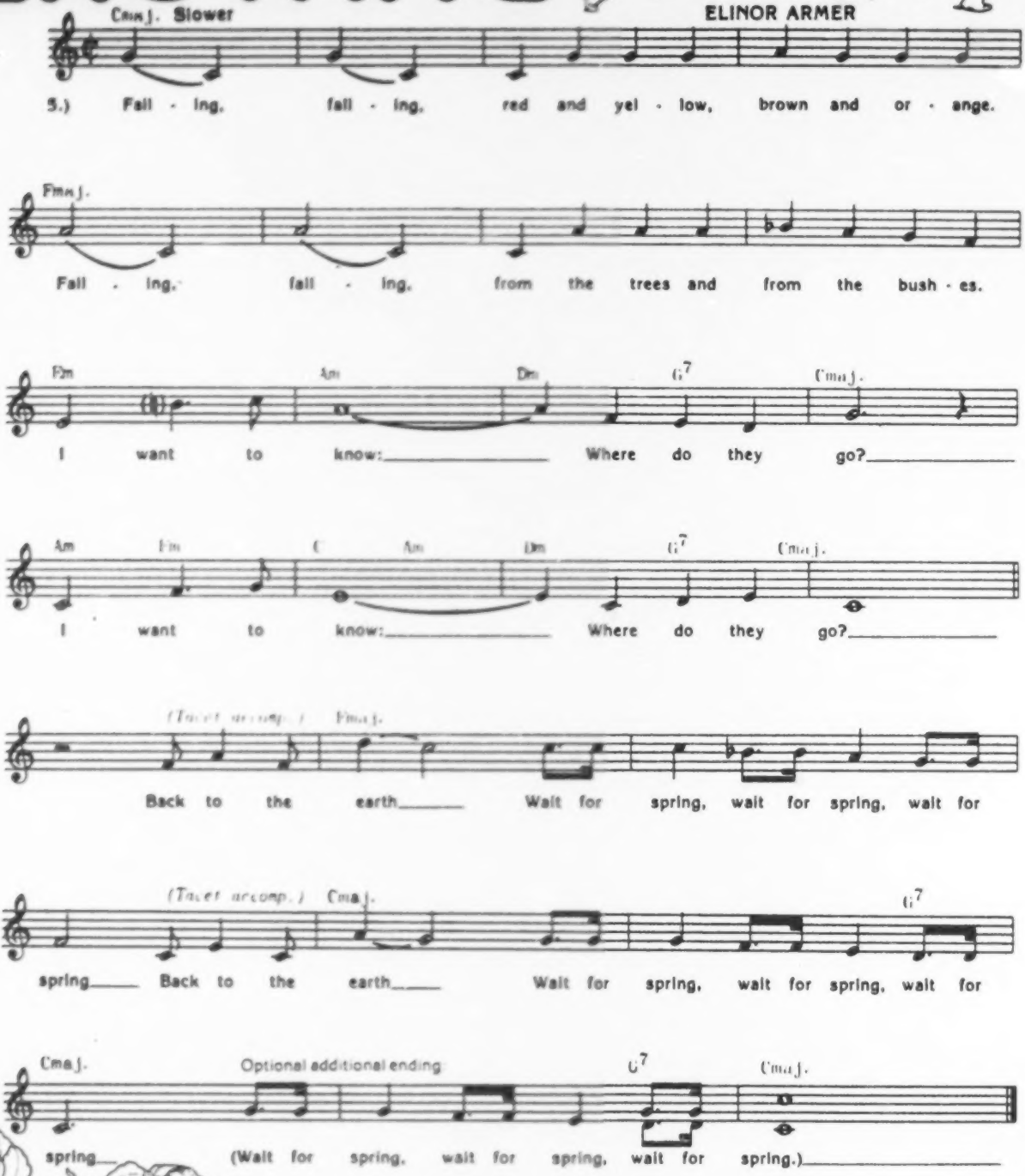
I'd like a tree to mark the spot
Where I am laid to rest
For that would be the epitath
That I would like the best.

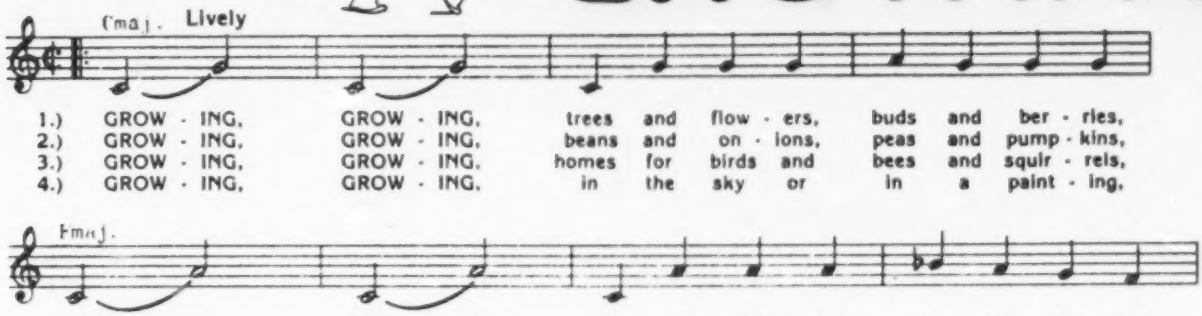
Tho it's not carved upon a stone
For those who come to see
But friends would know that resting there
Is he, who loved a tree.

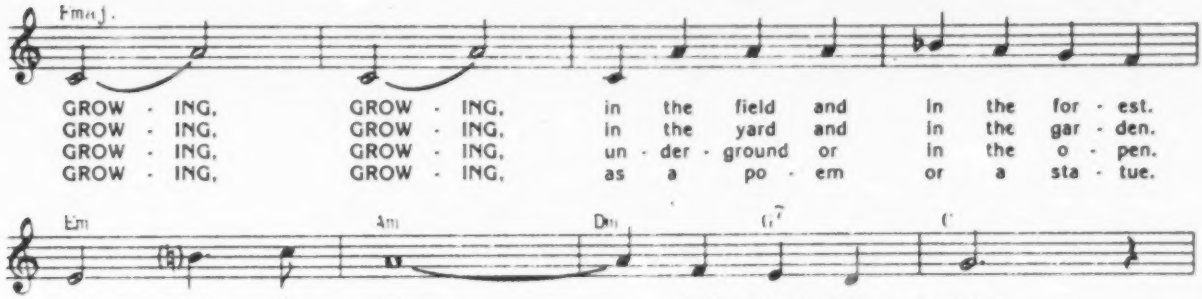
--Samuel N. Baxter

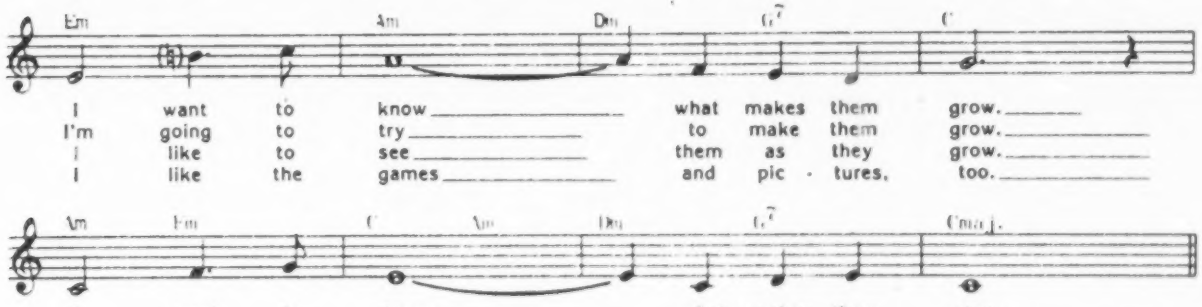
GROWING

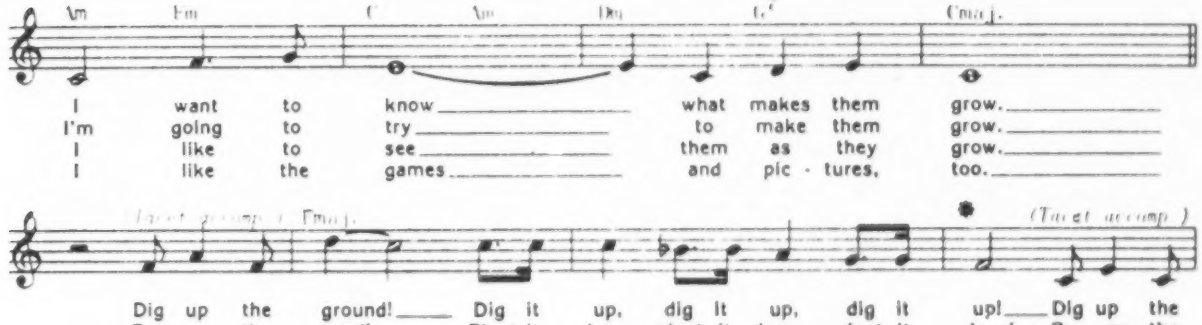
Words and Music by
ELINOR ARMER

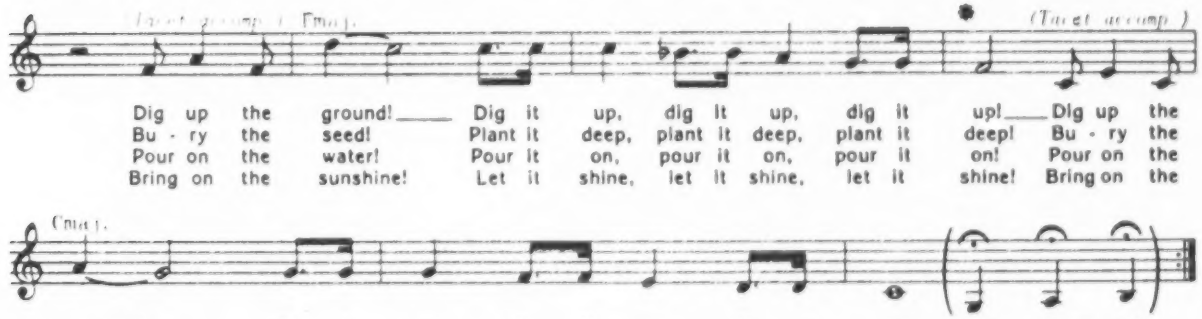


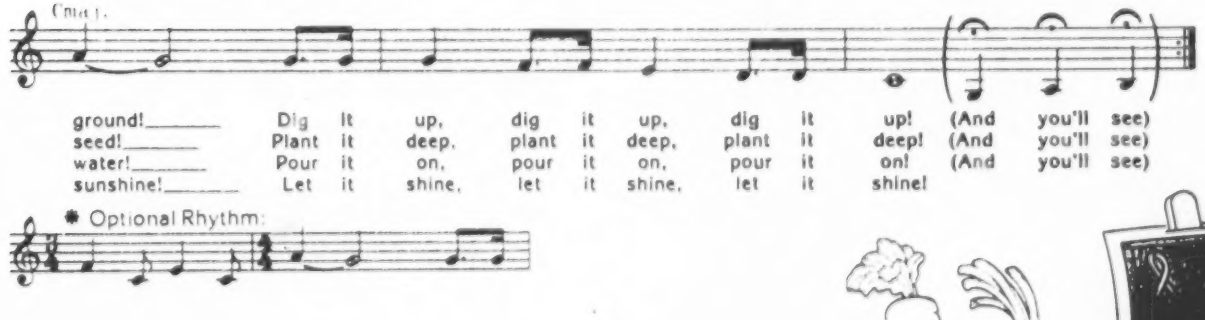


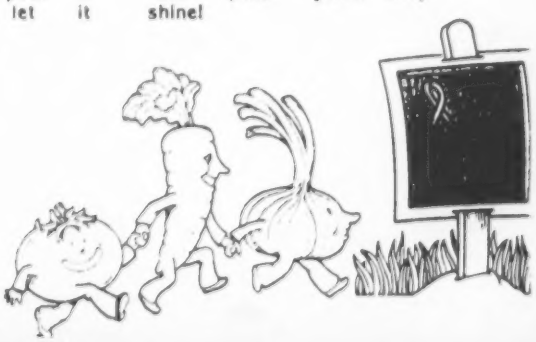












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Bibliography

This book is a compilation of activities from many wonderful sources. If you wish to purchase complete publications, please contact these sources directly.

Activity 1. *History of Arbor Day.* Information taken from "Planting Seeds–Growing Minds." California Association of Nurserymen. 4620 Northgate Boulevard, Suite 155, Sacramento, CA 95834. "Celebrate Arbor Day." National Arbor Day Foundation. 100 Arbor Avenue, Nebraska City, NA 68410.

Activities 2, 7 and 8. *Mobile From Tree Parts, Tree Collage and Alphabet Hunt.* The Sacramento Tree Foundation. 201 Lathrop Way, Suite F, Sacramento, CA 95815. (916) 924–8733.

Activities 3, 4 and 5. *Natural Resources Fill in the Blank, Don't be a Litterbug and Lion in the Trees.* "Conservation for Children." Sopris West, Inc. 1140 Boston Avenue, Longmont, CO 80501. (303) 651-2829.

Activities 6, 21 and 22. *Adopt a Tree, Classroom Conservation and Who Runs This Place.* " Project Learning Tree." American Forest Council, Washington, D.C. (202) 463–2472.

Activities 11, 12 and 13. *What is a Tree, How a Tree Grows and Tree Seasons and Cycles.* " Trees: Urban Forestry for Children." University of California Cooperative Extension. 4145 Branch Center Road, Sacramento, CA 95827.

Activities 9, 10, 16, 17 and 24. *Picture Your Thoughts, What's Your Angle... Gravity, Measure for Measure, Fun With Seeds, Growing Growing.* "A Child's Garden." Chevron Chemical Company. 6001 Bollinger Canyon Road, San Ramon, CA 94583.

Activity 14. *Identification Game,* Adapted from "Sharing Nature with Children." Joseph Cornell. Available from the Effie Yeaw Nature Center. American River Natural History Association. P.O. Box 241, Carmichael, CA. 95609. (916) 489–4918. A very useful companion book for this activity is *"Sacramento's Outdoor World, A Local Field Guide,"* and is also available at the Effie Yeaw Nature Center.

Activity 15. *A Seed is a Beginning.* "Planting Seeds–Growing Minds." California Association of Nurserymen. 4620 Northgate Boulevard, Suite 155, Sacramento, CA 95834. (916) 567–0200.

Activities 18 and 19. *Water, Cities Change the Environment.* "A Place to Live." National Audobon Society Education Division. 950 Third Avenue, New York, N.Y. 10022.

(212) 546-9100.

Activity 20. *School Energy Map.* "Conserve & Renew." The Regional School Energy Extension Project. Energy Center Sonoma State University. 1800 E. Cotati Avenue, Rohnent Park, CA 94928.

Activity 23. *Arbor Day Poems.* "Celebrate Arbor Day." National Arbor Day Foundation. 100 Arbor Avenue, Nebraska City, NA 68410.